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WAR DEPARTMENT

TECHNICAL MANUAL

INCENDIARY BOMBS

March 23, 1942

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E. O. D. TEAM

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No. 3–330

WAR DEPARTMENT,
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INCENDIARY BOMBS

SECTION		Paragraph
I.	General.	
	Purpose	1
	Scope	2
	References	3
II.	Types of incendiary bombs.	
	General	4
III.	Bomb, incendiary, 4-pound.	
	General	5
	Types	6
	Functioning	7
	Markings	8
	Handling at airdromes	9
	Extinction	10
	Treatment of burns from 4-pound bombs	11
IV.	Bomb, chemical, 30-pound, M1 (WP).	
	General	12
	Use	13
	Description	14
	Components	15
	Functioning of fuze	16
	Releasing	17
	Markings	18
	Handling at airdromes	19
	Airdrome storage and transport	20
	Phosphorous fire extinction	21
	Treatment of phosphorus burns	22
V.	Bomb, incendiary, 100-pound, M47 (gasoline-rubber-filled).	
	General	23
	Use	24
	Description	25
	Components	26
	Fuze M108	27
	Markings	28
	Releasing	29
	Fillings	30
	Handling at airdromes	31
	Gasoline and oil fire extinction	32
	Airdrome storage and transport	33
VI.	Packing, marking, and shipping.	
	General	34
	Packing	35
	Marking	36
	Shipping	37

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SECTION VII. Depot storage. Paragraph
General 38
Bomb, incendiary, 4-pound 39
Bomb, chemical, 30-pound, M1 (WP) 40
Bomb, incendiary, 100-pound, M47 (gasoline-rubber-filled) 41
Page
APPENDIX I. Bomb, incendiary, instructional, M1 and M2 45
II. List of references 49

SECTION I

GENERAL

Paragraph
Purpose 1
Scope 2
References 3

1. Purpose.—This manual is published for the information and guidance of the using arms and services.

2. Scope.—The information contained herein includes the description, means of identification, directions for handling, specifications for storage, packing, and shipping, and the necessary safety precautions relating to incendiary bombs.

3. References.—References and sources of additional information will be found in appendix II.

SECTION II

TYPES OF INCENDIARY BOMBS

Paragraph
General 4

4. General.—*a. Bomb.*—The use of the term "bomb" in this manual will in all cases be understood to refer to aircraft bombs, that is, bombs loaded into, transported by, and released from aircraft for purposes of incendiarism.

b. Incendiaries.—Incendiaries are combustible materials which are burned with intent to cause destruction of buildings, crops, food, ammunition, or materials of military importance.

c. Classification.—Incendiary materials, dependent upon their construction and manner of use, are classified as *intensive* or *scatter*. The intense type remains as a unit until consumed of itself, thus confining its heat to a restricted area. The scatter type disperses small fragments of its burning material, usually by an explosive charge thus starting simultaneously as many fires in as many different places as possible.

d. Design types.—This manual is concerned with three design types of incendiary bombs only: The two AN–M50–A1 standard magnesium alloy and the two AN–M54 substitute standard steel-body 4-pounders; the 30-pound white phosphorus; and the 100-pound gasoline-rubber-filled bomb.

SECTION III

BOMB, INCENDIARY, 4-POUND

	Paragraph
General	5
Types	6
Functioning	7
Markings	8
Handling at airdromes	9
Extinction	10
Treatment of burns from 4-pound bombs	11

5. General.—*a. Designations.*—Each of the four 4-pound incendiary bombs bears the specific prefix "AN–M", and an individual numbered suffix to differentiate one from another.

b. Classification.—This group is divided into two sets of classifications, the first being determined by the metal constituent of the bomb body, and the second by the presence or absence of a burster charge of approximately 170 grains of black powder.

(1) The bomb with the body constructed of magnesium alloy *without* a burster charge is designated AN–M50–A1. This same bomb *with* the burster charge becomes AN–M50X–A1.

(2) The bomb of steel-body construction *without* burster charge is designated AN–M54; *with* burster charge as AN–M54X.

(3) In every respect other than the presence or absence of the burster charge, AN–M50–A1 is identical with AN–M50X–A1, and the steel-body AN–M54 identical with the AN–M54X.

6. Types.—*a. AN–M50–A1.*—(1) *Description.*—This bomb measures $21\frac{11}{16}$ inches in length and $1\frac{11}{16}$ inches in width at the hexagonal cross section (across the flats), with the center of gravity located $6\frac{1}{2}$ inches from the tip of the nose. The bomb consists essentially of a hexagonal blunt steel nose, a cored magnesium alloy body containing a first fire charge and a thermate igniting composition, a striker unit with a safety plunger, and a hollow, hexagonal sheet steel tail. (See fig. 1.)

(2) *Weight.*—The total weight of the AN–M50–A1 type bomb is approximately 4 pounds, apportioned approximately as follows:

Magnesium alloy	1 pound 4 ounces
Steel nose	1 pound 8 ounces
Thermate igniting mixture	10 ounces

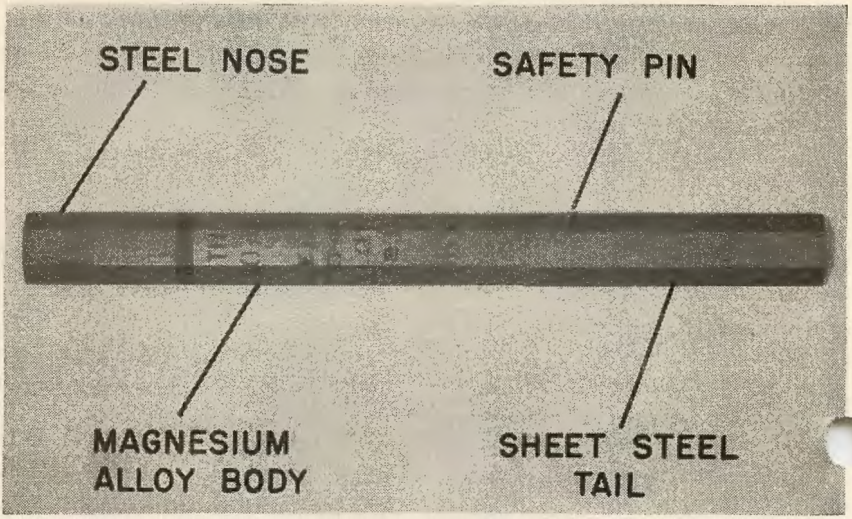


FIGURE 1.—4-pound incendiary bomb AN–M50–A1.

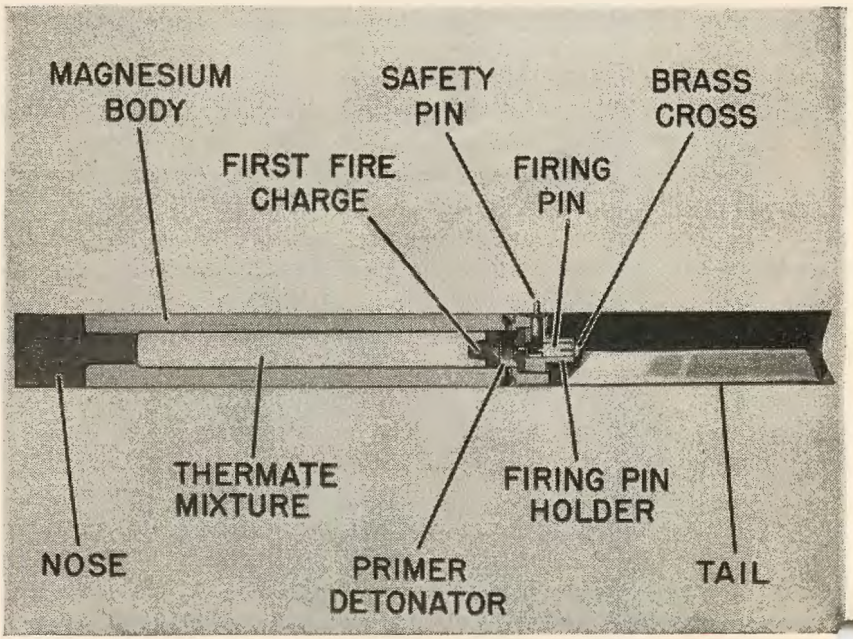


FIGURE 2.—4-pound incendiary bomb AN–M50–A1, section view.

The firing mechanism and tail assembly constitute the additional weight.

b. AN–M50X–A1.—(1) *Description.*—This bomb is approximately equal in weight and identical in measurement with the AN–M50–A1, and differs only in composition in that it contains a burster charge of 170 grains of black powder. The burster charge is incorporated to make hazardous an immediate approach to a burning bomb, thus discouraging attempts at extinguishing all 4-pound incendiaries and thereby increasing the life span and burning efficiency of the standard nonexplosive incendiary AN–M50–A1. The burster-charged bomb may be said to "run interference" for the nonexplosive bomb. Approximately 20 percent of 4-pound magnesium alloy bombs in a cluster are of the AN–M50X–A1 type.

(2) *Burster charge.*—The black powder burster charge is contained in a metal case near the nose of the bomb. The presence of the burster charge decreases the weight of the thermate igniting mixture (not the first fire charge) by a slight amount.

c. AN–M54.—(1) *Description.*—Although within a fraction of an ounce of the same weight and of almost identical appearance, the AN–M54 differs considerably from the AN–M50–A1 in its construction. The major difference is in its body, which is of tubular steel, and in the amount of the thermate igniting mixture. There are, also, other differences in the weight and shape of the steel nose, in the design and operation of the firing mechanism, and in the weight and design of the tail. The lengths of the two are identical, and the diameters of the hexagonal noses and tails are almost the same. The center of gravity of this steel-body bomb, however, is 6 inches from the tip of the nose, or one-half inch nearer the nose than in the magnesium type.

(2) *Weight.*—As with the 4-pound magnesium bomb, the weight of this incendiary is approximately 4 pounds, apportioned approximately as follows:

Steel body	1 pound 6 ounces
Steel nose	10 ounces
Thermate igniting mixture	1 pound 10 ounces

The additional weight is distributed in the tail assembly and firing mechanism.

d. AN–M54X.—(1) *Description.*—This bomb is identical with the foregoing AN–M54, except for the inclusion of a burster charge of 170 grains of black powder filled into the core near the nose as in the case of the AN–M50X–A1 magnesium bomb.

(2) *Burster charge.*—The purpose of the burster charge is the same as that of the AN–M50X–A1.

7. Functioning.—*a. AN–M50–A1.*—(1) *General.*—The design of this bomb is such as to set in motion the first of its functions immediately upon impact when released from a height of 50 feet or more

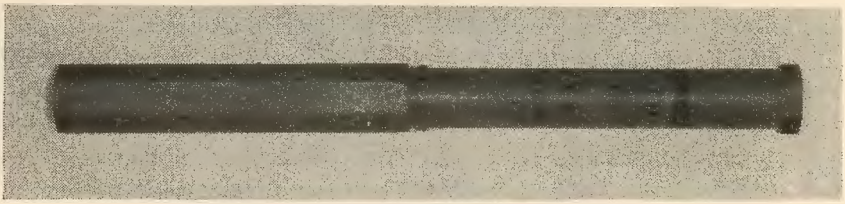


FIGURE 3.—4-pound incendiary bomb AN–M54.

above a target. Greater heights of release are always used, however, so that a maximum velocity consistent with a predetermined accuracy may be obtained, thus assuring to the bomb a maximum penetration upon impact.

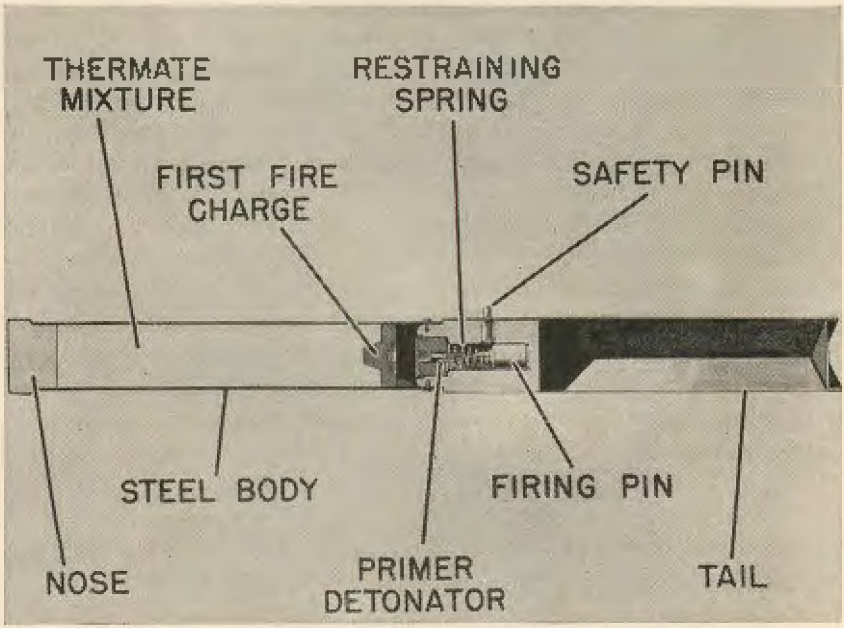


FIGURE 4.—4-pound incendiary bomb AN–M54, section view.

(2) *Ignition mechanism.*—Throughout the period of its release, and immediately upon impact, all parts of the bomb remain immobile and intact. During this time the firing pin, or plunger, is held suspended above the primer, or cap, by a small lateral cross of thin brass. Upon the shock of impact, and the termination of the bomb's

downward flight, the force exerted upon the suspended firing pin is sufficient to send it downward through the firing pin holder, pulling after it the thin brass cross. The consequent impact of the pin upon the primer ignites the first fire charge. Then, in sequence, the fire charge ignites the thermate mixture and this the magnesium alloy body. For a period of approximately 10 minutes the body burns at the intense heat of 2,300° F. to 2,500° F.

b. AN–M50X–A1.—The ignition functioning of this bomb is identical with that of the AN–M50–A1 except that its burster charge of black powder explodes approximately 1½ minutes after impact and ignition of the thermate mixture.

c. AN–M54.—This steel-body bomb functions in a manner similar to that of the AN–M50–A1, although its firing pin assembly is of different design. The firing pin plunger, rather than checked by the thin brass cross, is restrained by a 1¼-inch long thin wire spring attached to its nose. This spring has a pressure resistance equal to 25 ounces in weight. The shock of impact is sufficient to compress the spring and permit the plunger to travel downward in the core of the firing pin holder until its point fires the primer, thus igniting the thermate mixture in the bomb core. For approximately one minute the thermate burns fiercely at a temperature between 4,300° F. and 4,400° F. This intense heat melts the tubular steel body, releasing molten metal to run in many directions, searing and setting afire combustible material with which it may come into contact.

d. AN–M54X.—Functionally identical with the AN–M54, this steel-body bomb, as in the case of the AN–M50X–A1, burns for 1½ minutes before explosion.

8. Markings.—Information letters and band markings on all 4-pound bombs appear in purple, the color selected to indicate incendiaries. The lettering is in panel form, surmounted by the band, on the body of the bomb, and gives the following information in two-sized letters thus—

Purple band	[ ]	½-inch height each line.
Thermate	TH	
Model number	50–A1	
Loader's initial or symbol	EA	⅜-inch height each line.
Date of filling	10–41	
Loader's lot No	LOT 123	

9. Handling at airdromes.—*a. Care and preservation.*—Extreme care should be exercised to insure that these bombs are stored in a dry place well removed from heat and fire. Rough handling is *prohibited.* If the airtight seal of the shipping containers is broken, the first fire charge of the bombs will absorb moisture, which will

radically interfere with ignition of the bomb. This is especially true of moisture-laden bombs loaded into an airplane and carried aloft. The extreme low temperature of high altitude then causes the first fire charge to freeze, thereby rendering the bombs completely useless for incendiary purposes.

b. Preparation of bombs for release.—(1) *General.*—Incendiary bombs of the 4-pound type are released aloft from airplanes in clusters by means of a simple mechanism known as the cluster adapter. In this manner the bombs do not fall singly at first, but for a second or two remain bunched. Upon release they fall clear of the bomb bay, the slipstream of the airplane lastly tearing the cluster apart and permitting the bombs each to pursue its own downward course. There are two types of cluster adapters which, although constructed the same fundamentally, nevertheless are released, and the bombs "armed," by altogether different methods.

(2) *Cluster adapter T2.*—(*a*) *Description.*—This adapter is composed of two thin steel end plates attached at right angles to two steel rods. The end plates are approximately 9 inches in diameter somewhat resembling a rounded shield or fat letter "U" closed at the top. One of the rods is of $\frac{7}{16}$-inch diameter, being solid, while the other is hollow with a $\frac{3}{4}$-inch outside diameter. The hollow rod, open at one end, is attached to the top centers of the end plates; the solid rod to the bottom. A series of four small transverse horizontal holes in the hollow rod are at equal distances between the ends. At about one-third the distance from each end is welded a steel supension lug. (See fig. 5 for further detail.) Long wires pass through the four series of holes in the hollow rod. These encircle a total of 34 bombs separated into two equal lots, and each bomb is positioned so that its safetypin is imprisoned. A cluster adapter metal support plate of three angled sides, each side of which is the equivalent width of one of the hexagonal sides of the bomb nose and tail, is on each side of the cluster as a whole in such manner that the adapter plate grips the sides of three bombs. There are four such plates for a full adapter load, each plate being notched at its top and bottom. The wire through the hollow rod passes through the notches of the cluster plates and the ends are twisted together under the solid rod, thus insuring two fast, compact, and immobile clusters of 17 bombs each within the adapter. (See fig. 6.)

(*b*) *Assembly.*—A ball type cartridge is inserted into the open end of the hollow rod and assembled firing mechanism (with safetypin) screwed thereupon. The completed and loaded luster adapter is then attached to the airplane by means of the two suspension lugs

welded around and to the hollow rod, and the arming wire substituted for the safety pin in the firing mechanism. The airplane is now serviced for incendiary flight.

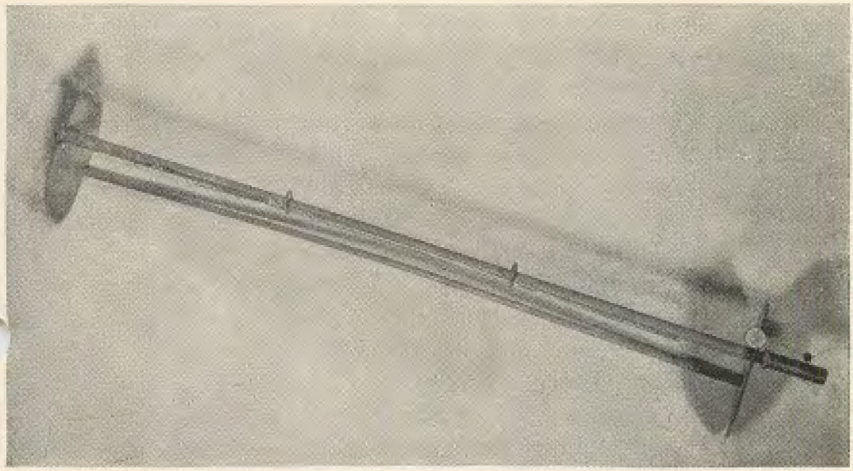


FIGURE 5.—Cluster adapter T2 (cartridge type), empty.

(*c*) *Releasing.*

1. Armed.—When ready for cluster release, the bombardier manipulates the bomb release control, which immedi-

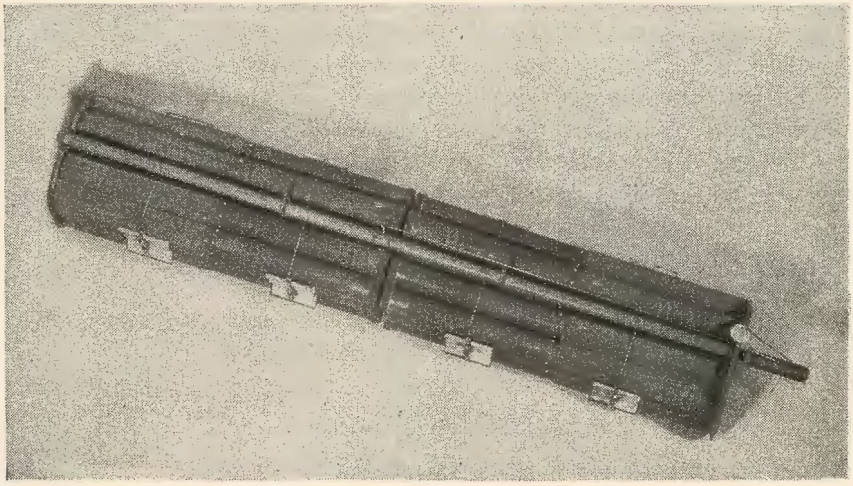


FIGURE 6.—Cluster adapter T2 (cartridge type), loaded.

ately drops the cluster free of the airplane. The arming wire, securely attached both to aircraft and to firing mechanism, snaps taut and frees the firing pin.

The cartridge fires, the bullet travels through the hollow rod, cutting the four wires holding the two clusters to the adapter, and the bombs tumble out. The bullet spends itself against the plug in the sealed end of the hollow rod. In a few seconds the bombs right themselves and speed earthward nose first, the slipstream of the airplane and the backwash of the propeller having dispersed them. The bombs are now said to be *armed*. While in a cluster their safetypins, positioned on springs, were held in place, or imprisoned, by the pressure of one bomb against that side of another containing the safetypin. In this manner the bombs either would not fire upon impact or fire very inefficiently. They were *unarmed*. The cluster must open for the bombs to be armed and must be dispersed for proper incendiary effect. In all operations the adapter falls as a unit to the earth, empty or filled, as the case may be.

2. Unarmed.—Should it be necessary or desirable to rid the airplane of its loaded cluster adapter unarmed, a mechanism is provided whereby the arming wire is *first* detached from the aircraft. The cluster adapter is then set free, and falls with all its bombs as an intact unit.

(*d*) *Cluster adapter marking.*—It should be noted that the 4-pound incendiary bombs are not only manufactured as complete units in munitions plants, but as well are grouped in clusters, each cluster "spotted" with its approximate 20 percent ratio of explosive, or "X" bombs, and the finished cluster properly loaded into the cluster adapter and secured as described above. The complete cluster is then packed in its shipping box, together with the arming wire. For this reason it is necessary that proper information be shown upon each cluster adapter. Depending upon the type of bomb, the following facts are stenciled in black upon the outside of one of the adapter end plates:

CLUSTER ADAPTER 100 LB. T2

FOR

34 INCENDIARY BOMBS

4 LB. AN–M50–A1

(3) *Cluster adapter M3.*—(*a*) *Description.*—This cluster adapter is fundamentally similar to the cluster adapter T2, but of noticeably different design and appearance. In place of the two parallel rods

in the T2 adapter, two parallel channelized bars of approximately 1/16-inch sheet steel and 47/8 inches in length have been substituted. In addition, four 3/4-inch thin sheet-steel bands are substituted for

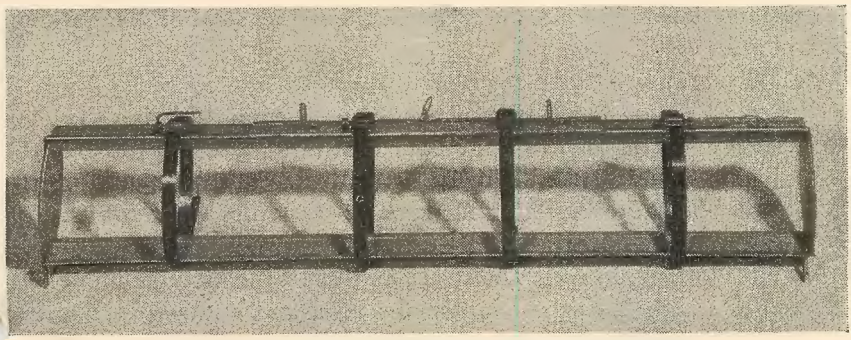


FIGURE 7.—Cluster adapter M3 (mechanical type), empty.

the four cluster circumscribing wires, and three manipulative suspension lugs set in a special affixed plate atop the upper bar supersede the two welded lugs of the T2 adapter. The cartridge and ball, and the four side support angled plates are not present. Four

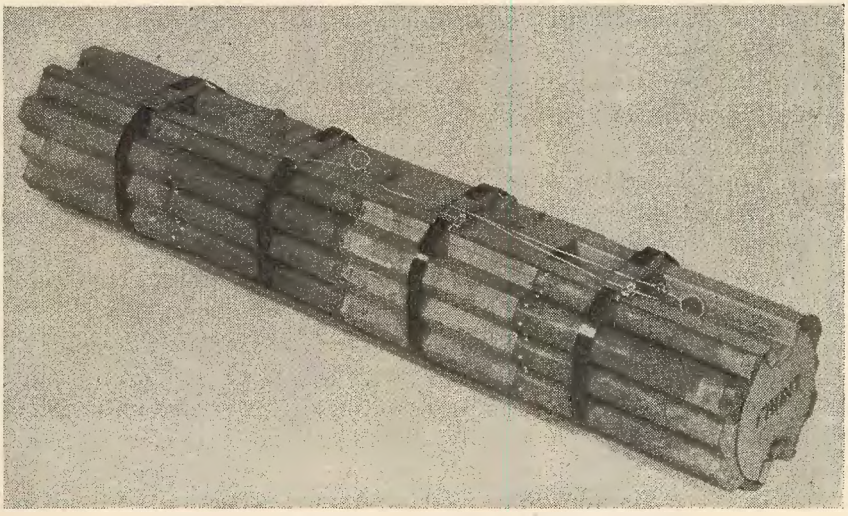


FIGURE 8.—Cluster adapter M3 (mechanical type), loaded.

steel bands circumscribe the clusters, with band ends meeting above the top bar of the adapter, thus holding the bombs within the adapter frame. Each such junction of ends is made fast by a common adapter-length locking pin, which is assembled to the cluster adapter

at the point of bomb manufacture. In the case of this cluster adapter, the four-pronged arming wire is likewise assembled to the adapter at the point of bomb manufacture.

(*b*) *Assembly.*—The full adapter is attached to the airplane by its suspension lugs. The last operation is the withdrawal of the common locking pin.

(*c*) *Releasing.*

1. Armed.—The action of the bombardier in releasing the cluster is the same for both adapters. He manipulates the bomb release control, which immediately lets fall the adapter. The four-pronged arming wire, which has been attached to the airplane, pulls taut, jerks the locking pin from the steel bands, and the bombs tumble out. In this type adapter the rods and end plates likewise fall apart and drop earthward.

2. Unarmed.—The same type of control for dropping unarmed clusters is provided for cluster adapter M3 as described for cluster adapter T2.

(*d*) *Cluster adapter marking.*—In addition to the information described as stenciled upon one of the end plates of cluster adapter T2, the opposite end plate of cluster adapter M3 will also bear the word "FRONT" for instruction in loading.

c. Safety precautions.—The following precautions for the handling of 4-pound incendiary bombs *must* be observed:

(1) Keep bombs *dry.*

(2) Keep bombs away from *heat* and *fire.*

(3) Handle bombs *carefully—do not drop.*

(4) Pull out safetypin in cluster adapter *after* insertion of arming wire—*never before.*

(5) Insert safetypin *before* removing arming wire when freeing airplane of unreleased cluster.

10. Extinction.—*a. General.*—The extinction of a burning 4-pound incendiary bomb requires care, knowledge, and preparation. It is extremely difficult actually to extinguish the magnesium alloy type, and altogether impossible in the case of the steel-body 4-pounders. In dealing with them efforts are aimed at control rather than extinguishment. Methods of control are discussed below; but in all instances one fundamental rule of conduct should be observed: *Do not approach the bomb after its ignition until the expiration of 2 minutes.* Both the spattering effect of the thermate igniting mixture and the burster charge explosion of the explosive bomb types are dangerous to personnel.

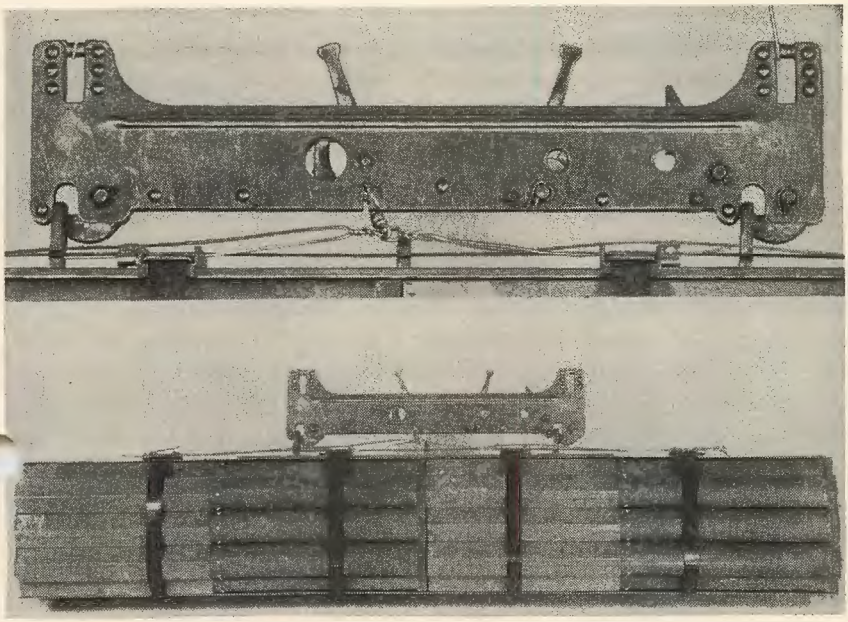


FIGURE 9.—Bomb release assembly (top) and loaded cluster adapter M3 attached to bomb release.

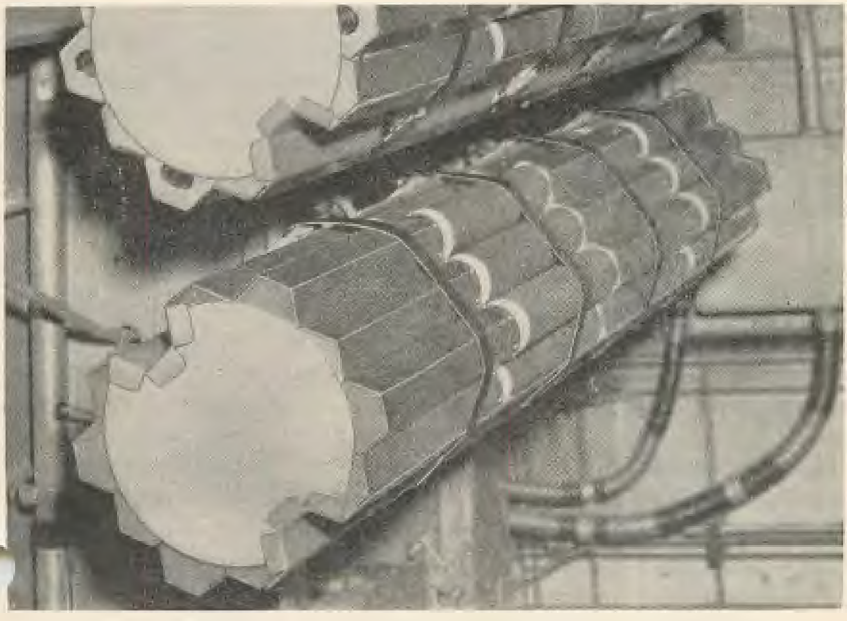


FIGURE 10.—Loaded cluster adapter M3 suspended in bomb bay of airplane.

b. Control of AN–M50–A1 and AN–M50X–A1.—(1) *Water.*—In the use of water for control, care must be taken that no large amount, such as a solid stream or a bucketful, comes quickly into contact with the burning bomb. Should such occur, the resulting explosion will scatter burning fragments of magnesium over a considerable area. A fine water spray applied to the bomb will accelerate its burning rate and thus decrease the burning time.

(2) *Solids.*—Almost any powdered solid that is not of itself combustible is, to varying degrees, effective in controlling a burning magnesium bomb. Such substances, when thrown upon the bomb, decrease the amount of oxygen, thus causing the bomb to burn less violently. It may then be approached more closely and, if possible, moved to a less vulnerable place. This removal should be effected by means of a long-handled shovel, or some similar implement, and the bomb deposited in some receptacle, the bottom of which is lined with some noncombustible solid, preferably of a powdery nature. This fire-resistant false bottom is most important, for without it the bomb might quickly burn through the vessel. Suggested solids include sand, commercial fire-resistant powders, talc, ashes, and earth.

(3) *Chemicals.*—Chemical fire extinguishers are no more effective than water, and should be used with caution because of possible harmful physiological effects resulting from the reaction of burning magnesium and ingredients of certain extinguishers. Carbon tetrachloride, the filling of one type of extinguisher, gives off a vapor with anaesthetic properties similiar to chloroform, and is therefore dangerous in confined spaces. Accompanying this vapor may also be the toxic gas phosgene. Carbon dioxide, in contact with burning magnesium, is broken down into carbon and the deadly carbon monoxide gas.

c. Control of AN–M54 and AN–M54X.—These thermate and steel bombs burn at a temperature between 4,300° F. and 4,400° F., and cannot be smothered by water, sand, or other materials. This is true because the thermate mixture contains its own adequate supply of oxygen. The bomb simply must burn itself out, which it will do in not more than 2 minutes. Personnel should take pains to dispose of the molten iron produced during the thermate reaction.

11. Treatment of burns from 4-pound bombs.—Particles of burning metal in contact with the skin should be removed at once. Should injury result from imbedded particles of the magnesium bomb, relief may be obtained by application of petroleum jelly or some equivalent substance. But in no case should water be applied, as this will stimulate the burning rate of the magnesium. For in-

jury due to the thermate and steel bombs, flooding the affected surface with water will cool the molten iron and afford relief. Further treatment, once the metal has ceased burning, will be the same as that for any other burn of like degree. Injury to eyes will require immediate medical or hospital treatment.

SECTION IV

BOMB, CHEMICAL, 30-POUND, M1 (WP)

	Paragraph
General	12
Use	13
Description	14
Components	15
Functioning of fuze	16
Releasing	17
Markings	18
Handling at airdromes	19
Airdrome storage and transport	20
Phosphorus fire extinction	21
Treatment of phosphorus burns	22

12. General.—The standard incendiary, designated "bomb, chemical, 30-pound, M1 (WP)," comes readily under the general definition of chemical bombs. Because its filling is of white phosphorus, it may perhaps lay greater claim to inclusion in this group than any other chemical bomb. Of the three accepted definitions of chemical bombs, the 30-pound M1 white phosphorus bomb meets them all—the production of an incendiary action, a screening smoke, and an irritating physiological effect.

13. Use.—Under the limitations imposed by its filling and light weight, the 30-pound white phosphorus bomb has nevertheless been designed to insure maximum accuracy consistent with its purpose. For this reason it will not usually be released from heights so great as those permitted of far heavier high-accuracy, high explosive bombs. Although its streamlining and tail or fin assembly reduce to some degree the effect of wind currents, the bomb's lightness seriously interferes with accuracy if very high release altitudes are selected. To insure that no injury from bomb splinters will come to releasing airplanes, or to nearby formations of friendly airplanes, or to flying personnel, this bomb should not be released from an altitude of less than 800 feet. Upon explosion the white phosphorus filling is effectively scattered over an area of 50 to 100 yards in diameter.

14. Description.—The bomb in appearance is that of a cylinder, tapering more noticeably toward the rear than the front. Upon

the rear end is superimposed the fin, or tail assembly, to insure stability and accuracy in flight. The nose is surmounted by the fuze, designated "fuze, bomb, Mk. XIV (nose)." The assembled bomb has a total weight of 32 pounds 12 ounces, of which amount 12 pounds 13 ounces constitute the white phosphorous filling. In length it measures 32⅜ inches from tip of nose to tail, with a maximum body

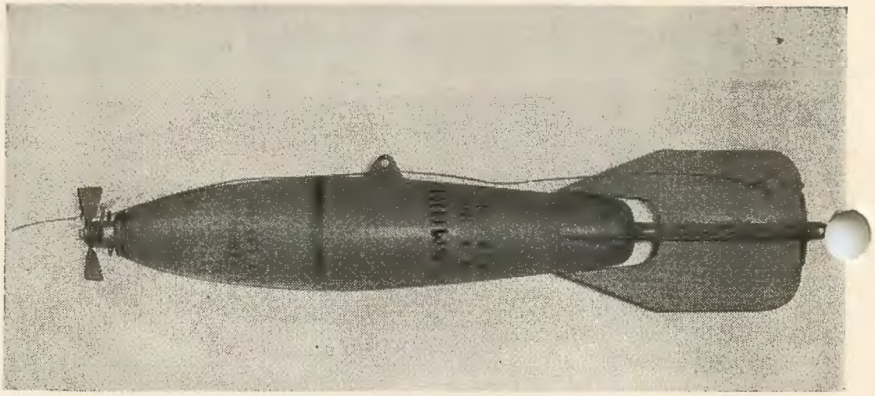


FIGURE 11.—30-pound chemical bomb M1 (WP).

diameter of 4⅞ inches; the center of gravity is located 13 inches from the nose. Maximum width across the tail is 6¾ inches.

15. Components.—The complete round consists of the following:

Bomb, chemical, 30-pound, M1 (WP); without burster.
Fuze, bomb, Mk. XIV (nose).
Burster assembly (booster assembly M101).
Primer detonator, Mk. II B (or Mk. II C), instantaneous.
Wire, arming, assembly.

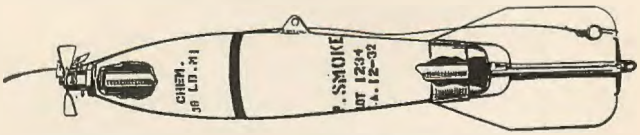


FIGURE 12.—30-pound chemical bomb M1 (WP), section view.

16. Functioning of fuze.—*a. General.*—The fuze contains the only mechanically operating part of the bomb. It consists of two subassemblies, the forward arming vane cup and the after firing pin sleeve, neither of which contains explosives.

b. Firing pin sleeve.—A short pin, thrusting through and extending beyond each side of the firing pin body, engages in two opposite slots, or "tracks", in the wall of the firing pin sleeve. This prevents rotary motion of the firing pin but permits backward movement in

the sleeve, the terminus of which is a shear, or temporarily restraining, wire. The design of the firing pin is such that a deep flange occurs immediately back of the head at its point of protrusion from the mouth of the sleeve. Around this flange are ranged eight ¼-inch steel balls in bearing fashion. Rather than as a bearing, however, these balls serve as an additional restraint to any backward movement of the firing pin. Were it not for a container of some sort, the balls could not be restrained in their arrangement, but would fall away from the flange.

c. Arming vane cup.—The arming vane cup, solid with its arming vane, provides this container when it is screwed to the outside of the mouth of the firing pin sleeve. A cotter pin, $\frac{3}{32}$ inch in diameter and 1½ inches long, inserted through one or two screw eyes on the outside of the firing pin sleeve and one of two matching eyelets of the arming vane, prevents undue oscillation or accidental unscrewing of the vane cup during handling. After the fuze is assembled to the burster well adapter, the arming wire is inserted to pass through either of these screw eyes and its matching eyelet preparatory to arming.

17. Releasing.—*a. Armed.*—When ready for release, the bombardier manipulates the bomb release control, which immediately frees the bomb from the bomb rack. The arming wire, securely attached to the aircraft, snaps taut, and the nose fuze pulls free of the arming wire. Once clear of the airplane, the arming vane spins immediately upon hitting the air, completes from 12 to 14 revolutions in a distance drop of approximately 2 feet, and whirls off into space. The eight balls instantly fall away and the firing pin head is left clear and protruding. Upon contact with the target the firing pin plunges backward along its slotted track, shears the restraining wire, and pierces the primer detonator, which in turn explodes the burster and therewith the bomb.

b. Unarmed.—Should it be necessary to rid the airplane of its bomb load unarmed, a mechanism is provided whereby the arming wire is *first* detached from the aircraft. Both wire and bomb then drop free together and strike without detonation.

18. Markings.—The 30-pound M1 white phosphorus bomb, constituting a bomb filled with a standard smoke agent, has all of its markings in yellow. The lettering, separated into two sections by one band, is in panel form on the body of the bomb. Type and weight designations are located slightly back of the body nose, and the filling indication equidistant to the rear of the center of gravity. The panel form is as follows:

CHEM.

30 LB. M1

(Band)

W. P. SMOKE

19. Handling at airdromes.—*a. Inspection.*—The assembly and disassembly of the 30-pound white phosphorus bomb include only those operations ordinarily required under field conditions. Because of the extreme care necessary to insure efficient and reliable explosion upon impact, specific examination of parts must be undertaken before assembly is begun. These inspections are as follows:

(1) *Cavities.*—To insure that no foreign matter is therein which might interfere with proper junction of mating parts.

(2) *Threads.*—To insure that no rust, injury, or foreign matter will interfere with proper mating, sealing, or seating.

(3) *Fuzes.*—To insure against rust or corrosion. Only serviceable fuzes may be used.

(4) *Tail.*—To insure secure attachment to bomb body and proper alinement of fins with body.

(5) *Lugs.*—To insure that tail and body suspension lugs are sturdy and undamaged. The lug for horizontal suspension should be gaged by means of a standard bomb shackle to assure proper center distance and alinement.

b. Assembly.—All assembly and disassembly operations described herein will ordinarily be performed at safe distances from magazines or other points where explosives may be stored. The operations of assembly, in the order of their sequence, are as follows:

(1) The closing nose plug in the burster well adapter of the bomb is unscrewed and removed.

(2) The burster (booster assembly M101) is inserted in the burster well until it seats firmly upon the bottom of the well. This is a simple insertion, and involves no screwing. The burster charge consists of 980 grains of tetryl.

(3) The fuze (*not* the primer detonator) is next fully screwed into and immediately screwed out again from the burster well adapter. This is done only to test the threads both of the fuze and of the adapter prior to insertion of the primer detonator. In every instance the fuze must screw in and out freely, and without the use of tools or force.

(4) With the fuze unscrewed and removed, and all threads checked, the socket in the burster is gaged to insure that the primer detonator will enter freely and seat properly in the socket. For this purpose a gage of the same size and shape as the primer detonator, improvised locally, may be used.

(5) The primer detonator is now inserted in the burster socket and seated. This is likewise a simple insertion, and should be accomplished without friction, and without the use of force or tools.

(6) With its cotter pin in place, the vane cup of the fuze is next tested, the propeller-like vane being oscillated to insure freedom of action.

(7) Lastly, the fuze itself is screwed carefully into the nose adapter (burster well adapter) *by hand* and without force. The bomb is now assembled. Only the attachment of the arming wire remains to complete the fuzing.

(8) It will be observed that the arming vane and the firing pin sleeve of the fuze have directly opposed pairs of matching screw eyes and eyelets, with one such pair containing a cotter pin. The method of attachment of the arming wire depends upon the manner in which the bomb is to be placed in the bomb bay of the airplane, that is, whether for vertical or horizontal suspension and release. These attachment methods are described below.

(*a*) *For vertical suspension.*—The arming wire is measured out reasonably straight and its clean-cut end threaded through the empty screw eye and eyelet until it protrudes for a distance of 2 or 3 inches beyond the arming vane. A safety clip is then fastened to the wire in such manner that the clip barely touches the face of the vane. The wire is now passed backward along the body of the bomb until its swivel loop end reaches the upper rear edge of the tail assembly directly in line with the point of insertion in the fuze. Here a serrated wire paper clip is assembled to the eye of the swivel loop and temporarily attached to the edge of the fin. This prevents dangling of the wire. The bomb is now completely fuzed.

(*b*) *For horizontal suspension.*—The fuze must be examined to determine which pair of matching screw eyes and eyelets is in that position nearest in a straight line to the suspension lug upon the body of the bomb. This is the eye and eyelet through which the arming wire must be threaded. If this pair is empty, well and good; should it contain the cotter pin, then a second cotter pin is inserted in the opposite empty pair. The pin in the nearer eye and eyelet is then withdrawn and the clean-cut end of the arming wire inserted. The wire in issue length is too long for horizontal suspension, and

must be measured and shortened. The swivel loop end is therefore placed 2½ inches to the rear of the suspension lug on the bomb body and the wire drawn reasonably taut until its clean-cut end protrudes from 2 to 3 inches beyond the eye and eyelet of the fuze. The wire is then cut at this point and the safety clip attached to the cut end as previously described. The bomb is now completely fuzed.

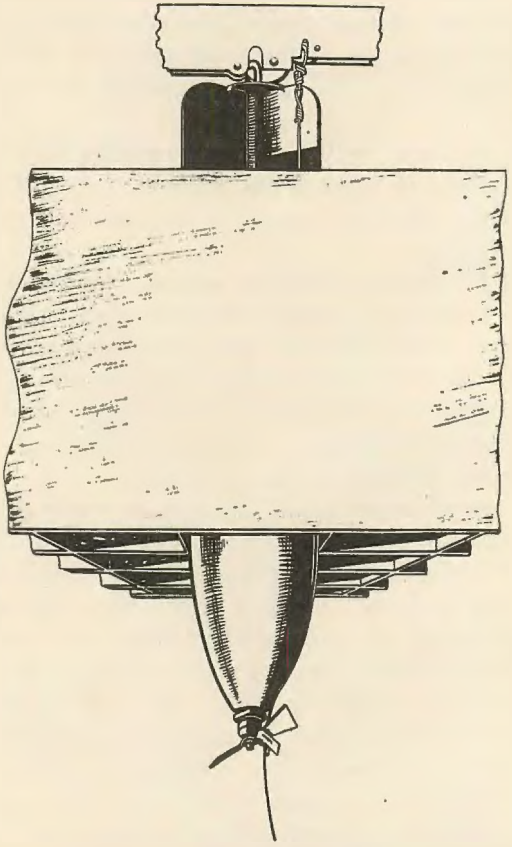


FIGURE 13.—Vertical suspension of 30-pound M1 (WP) bomb in bomb bay of airplane.

(*c*) *Caution.*—In no instance will the arming wire be threaded through either of the suspension lugs.

c. Disassembly.—Should it become necessary to remove the fuze from the body, or to disassemble the complete round into its component parts, the above operations are repeated in their reverse order, and all components restored to original condition and packing.

20. Airdrome storage and transport.—*a. Storage.*—Bomb components which are not of themselves waterproof are packed in either moisture-resistant or waterproof containers. When bombs are removed from airplanes and disassembled, all parts are inspected, cleaned, and returned to their original or similar packing. In no instance should packing seals be broken until the items are required for use. If unsealed and unused, the components should be resealed when repacked. Ordinarily bombs will be held as assembled complete rounds only in sufficient quantities to meet immediate requirements. Whether as assembled units or as packed components, they should be stored in a dry, safe place, preferably a building separate from others, and under a temperature as moderate and unchanging as possible. As with assembled rounds mentioned above, unassembled components ordinarily will not be stored in airdromes in quantities larger than necessary for anticipated needs.

b. Transportation.—The line of transportation within the airdrome area is a three-point one, beginning with the place of storage, running thence to the assembly and fuzing point, and terminating at the bomb service site. The service of the line necessitates a tandem of motor-truck and trailer, each with its necessary equipment and accessories. This tandem is designated "truck, bomb service, M1", and "trailer, bomb, M5." All specified components for the required number of complete rounds are loaded upon the trailer at the storage or distributing point and moved forward to the place selected for assembly and fuzing. The location of this second site, as with the distributing point, is determined by considerations both of convenience and of safety. The fuzed bombs are then reloaded upon the trailer and driven to the bomb service point, where they are unloaded. At this instant the method of unloading is determined by two factors: the weight and design of the bomb and the consequent ease or difficulty in handling; and the clearance between the bomb bay, or magazine, of the airplane and the ground. When clearances permit, the installation of the assembled bombs in the airplane is facilitated if the trailer with its load is maneuvered under the bomb bay. Otherwise the bombs are delivered beneath the bomb bay by means either of the bomb tray and lift truck, or individually by hand, depending upon the design and weight of the bomb. The "bomb service point" is not simply a place or site but specifically that point immediately beneath the bomb bay of the aircraft. At this point all installations and further bomb service are assumed by Army Air Force personnel.

c. Care and preservation.—In addition to the several maintenance considerations discussed in *a* and *b* above, other factors in the care

and preservation of 30-pound white phosphorus bombs should be noted. These relate, in the main, to the handling of parts, and especially to the primer detonator, which is the most sensitive of all components. At all times this part must be handled with the greatest care and forethought. It is particularly susceptible to heat and shock, and a fall of even a few inches may cause the primer to fire. No two of them ever should be permitted to strike together or to be struck by other objects, and every precaution should be taken to prevent friction. Should a primer detonator tend to bind upon insertion in the bomb, then another should be substituted and the first carefully laid aside. Should the trouble persist, then a second bomb should be substituted and the first bomb laid aside. No force ever should be applied, as such might result in injury to the primer detonator. It is more than likely that the obstinate detonators will seat easily in other bombs. And, lastly for the detonator, it should never under any circumstances be disassembled. The burster well is also important. Should the noseplug be mislaid or lost and the bomb consigned to storage, then the nose adapter should be closed by a wooden peg or with waste for the protection of the well from possible rust or corrosion. It is likewise best not to unscrew the arming vane from its conjunctive firing pin sleeve because of possible maladjustment upon reassembly.

d. Safety precautions.—The following safety regulations must be observed wherever applicable:

(1) Never disassemble the fuze in the field.

(2) Never force the primer detonator into the burster socket; to do so is almost certain to result in an accident.

(3) Never strike, drop, abrase, cut, heat, or attempt to disassemble the primer detonator; *this is imperative;* reject, return, or destroy it.

(4) Never heat, cut, or abrase the burster (booster assembly M101).

(5) Never unscrew the arming vane assembly once the fuze has been mated with the primer detonator in the bomb.

21. Phosphorus fire extinction.—Phosphorus fires may readily be extinguished with water. When the water has drained off, however, the phosphorus solids will reignite spontaneously and burn until consumed of themselves. It is best to flush or otherwise treat the unburned quantities with a solution of 2 or 3 percent copper sulfate. This produces a chemical reaction which results in the formation of a noncombustible coating on the phosphorus.

22. Treatment of phosphorus burns.—Phosphorus is a poisonous chemical element, and must at all times be handled with caution. Although its smoke is relatively nontoxic, long exposure to fumes

may nevertheless cause atrophy of the liver and inflammation and decay of the bone structure. Burns from the burning solid in lumps or small particles are severe and painful and should be treated immediately. Affected parts should be immersed in or flushed with water to stop the burning of the phosphorus. Should water be unavailable in volume, a wet cloth, mud, or damp earth will afford relief. The burning particles thus extinguished should then be removed from the affected parts as soon as possible. As with phosphorus fire on any surface, a prompt application of a 2 or 3 percent solution of copper sulfate will provide a coating and put an end to the burning at once. The coated particles must then be removed from the skin, and the burn treated and dressed as with any other of like degree.

Section V

BOMB, INCENDIARY, 100-POUND, M47 (GASOLINE-RUBBER-FILLED)

	Paragraph
General	23
Use	24
Description	25
Components	26
Fuze M108	27
Markings	28
Releasing	29
Fillings	30
Handling at airdromes	31
Gasoline and oil fire extinction	32
Airdrome storage and transport	33

23. General.—This bomb, designated "bomb, incendiary, 100-pound, M47 (gasoline-rubber-filled)," is the largest of the incendiary group discussed in this manual. Although not fulfilling so many of the ideal chemical bomb functions, it is an efficient incendiary when filled with the approved solutions described hereinafter. Equipped with an instantaneous action fuze, its detonation effectively scatters its burning filling over an area with a radius of approximately 20 yards. It is received empty and is filled, assembled, and fuzed in the field.

24. Use.—The design and construction of the M47 incendiary bomb is such as to provide maximum efficiency after release from the bomb bay of the airplane. Because of its considerable weight advantage and higher drop-accuracy, it may be released from greater altitudes than the white phosphorus bomb. In particular it is designed for use against special targets where large and numerous fires will cause serious damage.

25. Description.—The M47 gasoline-rubber-filled bomb, prior to filling and fuzing, consists of four main parts. These are the body, the tail assembly, the two suspension bands, and the burster well. The body is cylindrical, 8 inches in diameter, and fashioned of rolled and lap-welded $\frac{1}{32}$-inch sheet steel. With the sheet steel box-type tail riveted to its end, the length is 45 inches, and the weight, with burster well inserted, is 20 pounds. Center of gravity is located $18\frac{1}{2}$ inches from the nose. The fuze, designated "fuze, bomb, M108 (nose)," adds $2\frac{7}{8}$ inches to the over-all length. The tail assembly measures 8 inches in side width and $10\frac{15}{16}$ inches between cross-center flanges. Suspension bands, each containing a suspension lug, are of sheet steel. These bands tightly circumscribe the bomb body. When filled, assembled, and fuzed in the field, the M47 bomb weighs approximately 85 pounds.

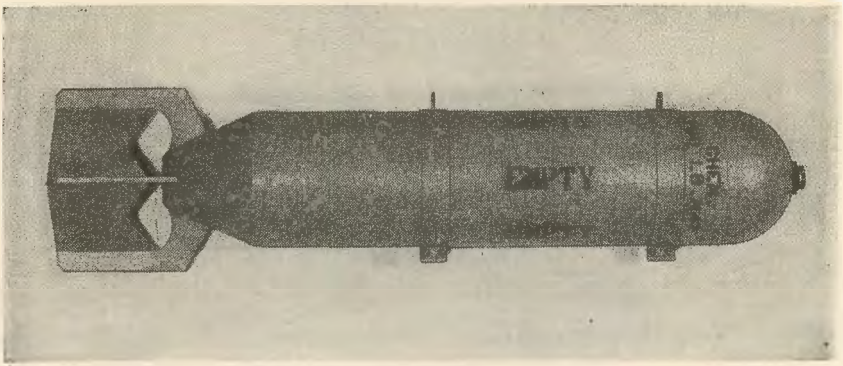


FIGURE 14.—Empty 100-pound incendiary bomb M47 with original markings.

26. Components.—The complete round consists of the following:
Bomb, empty, M47.
Incendiary filling.
Burster well.
Burster, M7.
Fuze, bomb, M108 (nose).
Wire, arming, assembly.

27. Fuze M108.—As previously stated, the fuze is of the instantaneous action arming pin type in which the primer and detonator are integral parts. At the rear of the body are two spring-actuated steel balls, diametrically opposed, which engage in the groove of the burster well adapter when the fuze is inserted in the nose of the bomb. This operation, performed solely by hand and without the use of force or tools, requires no screwing. A striker assembly protrudes approxi-

mately ¾ inch beyond the nose of the fuze body, and an arming pin, with two transverse eyelets and positioned on a compressed spring, extends through both fuze body and striker shaft, thereby preventing any movement of the striker. Also extending through both fuze body and striker is a shear or restraining wire. In the ¾-inch space between striker plate and fuze body is the safety block. This mechanism,

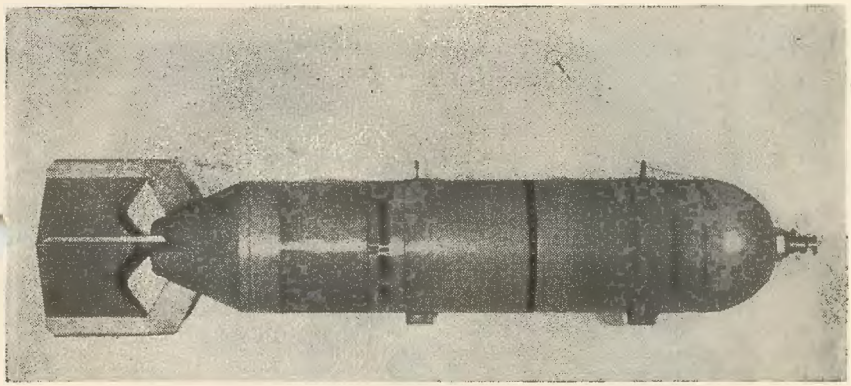


FIGURE 15.—100-pound incendiary bomb M47 filled, fuzed, and re-marked.

which must always be present, comprises a block with recess, a compressed spring to fit the recess and rest upon the striker shaft, and a holder to retain the block in position in the fuze. The arming pin likewise penetrates the safety block holder, and the cotter pin in the outer of the two arming pin eyelets restrains all movement of the fuze parts. Upon fuzing, the arming wire is threaded through the inner

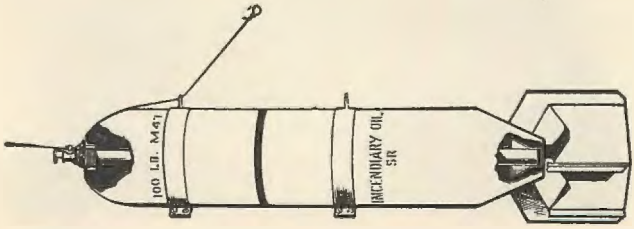


FIGURE 16.—100-pound incendiary bomb M47 fuzed and re-marked.

eyelet and the cotter pin removed. The primer and detonator are loaded in the rear of the fuze core.

28. Markings.—The markings upon the M47 gasoline-rubber-filled bomb are related more to field filling operations than to original receipt of empty bombs and are therefore discussed in detail in paragraph 31*d*.

29. Releasing.—*a. Armed.*—When ready for release, the bombardier manipulates the bomb release control, which immediately frees the bomb from the bomb rack. The arming wire, securely attached to the aircraft, snaps taut and the nose fuze pulls free of the arming wire. When the arming wire is withdrawn, the two compressed springs function, one ejecting the arming pin and the other the safety block. The bomb is now fully armed, with detonation restrained only by the

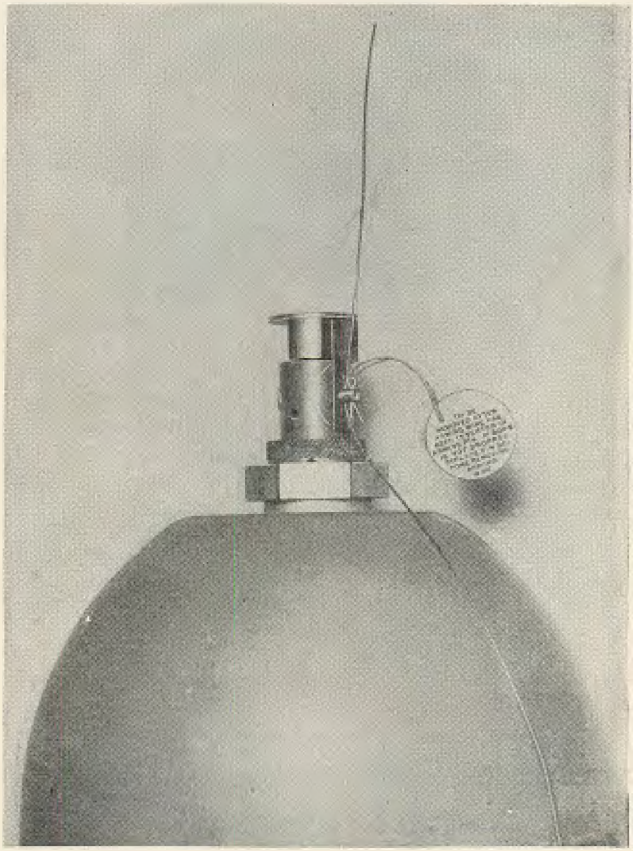


FIGURE 17.—Detail of fuze with safety block of 100-pound incendiary bomb M47.

shear wire. Upon impact the striker is driven through the shear wire and into the primer, which fires the detonator and this the burster. The explosion of the burster ignites and scatters the filling. The burning rubber ingredients have a tendency to cling to nearby objects, thereby starting fires.

b. Unarmed.—Should it be necessary to rid the airplane of its bomb unarmed, a mechanism is provided whereby the arming wire

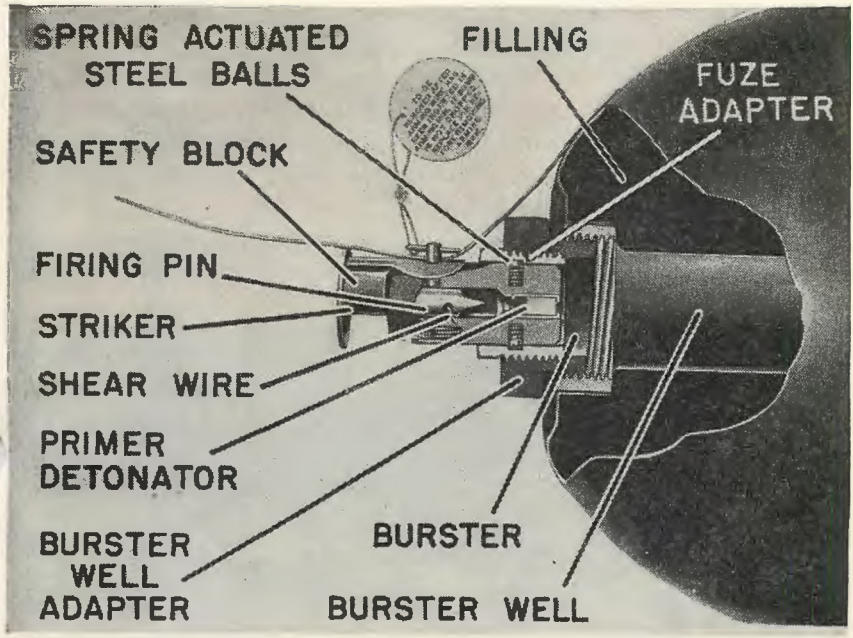


FIGURE 18.—Assembly of 100-pound incendiary bomb M47.

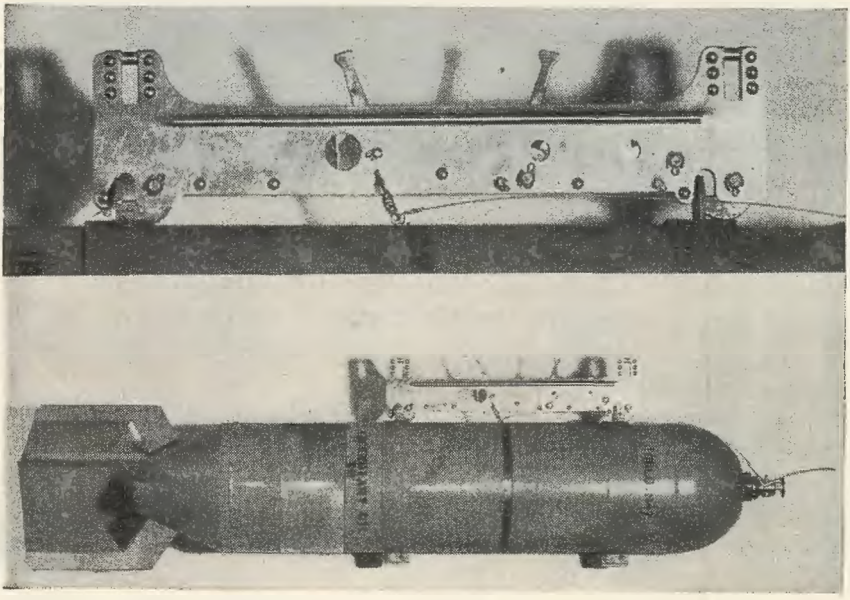


FIGURE 19.—Bomb release assembly (top) and filled and fuzed 100-pound incendiary bomb M47 attached to bomb release.

is *first* detached from the aircraft. Both wire and bomb then drop free together and strike without detonation.

30. Fillings.—*a. Ingredients.*—The standard fillings for the M47 incendiary bomb comprise a base filling of gasoline supplemented by one of four different incendiary ingredients. The gasoline serves both as an incendiary and as an ingredient solvent. The four basic incendiary constituents are as follows:

(1) *LA–60.*—LA–60 is crude latex, or sap, as drawn from rubber trees and concentrated for shipment. It is a creamy-white liquid of

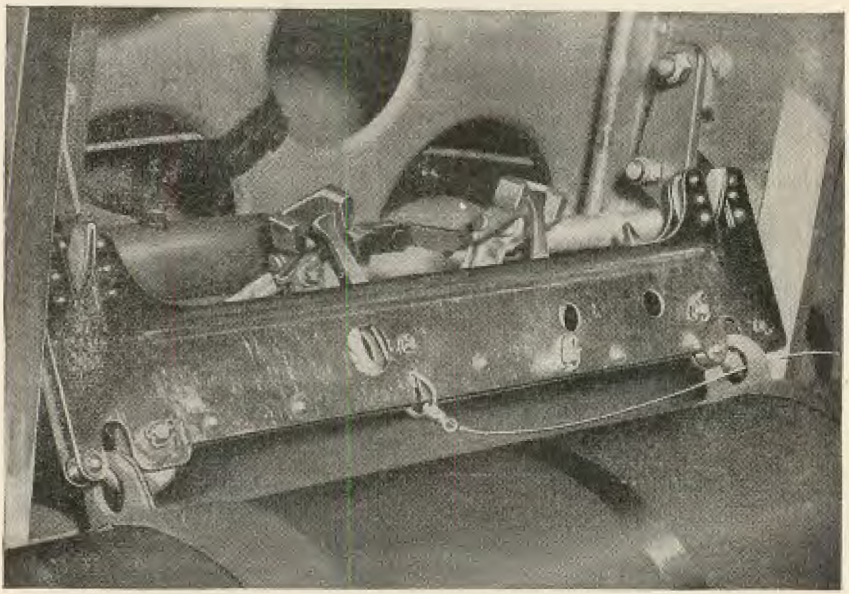


FIGURE 20.—Horizontal suspension of 100-pound incendiary bomb M47 in bomb bay of airplane.

about the same consistency as whipping cream. The material in this state comprises approximately 60 percent solid matter.

(*a*) *Caustic soda.*—The caustic soda used should be 95 percent pure sodium hydroxide.

(*b*) *Coconut oil.*—This is the yellowish oil expressed or extracted from coconuts. Upon exposure to air, the oil has a tendency to form a pasty mass having approximately the same consistency as cup grease. When fresh it has a distinctive coconut odor, but becomes rancid after standing. This latter odor is not objectionable, however, and does not impair the efficiency of the oil as an ingredient in incendiary solutions.

(2) *LA–100.*—LA–100 is also crude latex dried until it is approximately 100 percent solid. It is a light-tan colored substance procured in sheets of various thicknesses.

(3) *Crepe rubber (CR).*—This, too, is crude latex, but reduced to a solid by precipitation and kneading. It is likewise light tan in color, and is obtained in sheets of various thicknesses.

(4) *Smoked rubber sheets (SR).*—This is crude latex which has been dried over a smoky fire until it is approximately 100 percent solid. It is of a brownish color and comes in thin sheets.

b. Quantities.—The quantities of ingredients necessary for the preparation of the respective gasoline-rubber solutions required to fill 100 M47 bombs are given in table I.

TABLE I.—*Ingredients for 100 M47 bombs*

Ingredient	Unit of measure	Quantity			
		LA–60 filling	LA–100 filling	CR filling	SR filling
Gasoline	Gallons	500	600	575	500
LA–60	do	75			
LA–100	Pounds		280		
CR	do			370	
SR	do				460
Coconut oil	Gallons	55			
Caustic soda	Pounds	180			
Water	Gallons	25			

c. Equipment.—The following equipment and materials are prescribed as those desirable for mixing, filling, closing, painting, and stenciling M47 bombs:

(1) *Mixing.*—(*a*) *Drums.*—Three empty 55-gallon or 110-gallon, open-end, steel drums or barrels should be provided for preparing the LA–60 mixture.

(*b*) *Paddles.*—Three wooden paddles for stirring ingredients in the drums are necessary. These should be approximately 5 feet long with 4-inch width blades.

(2) *Filling.*—(*a*) *Support.*—A stand for supporting the bomb in an upright position during the filling and closing operations may be improvised from available lumber or metal. Such a stand should have sufficient stability to prevent any accidental upset of the bomb.

(*b*) *Scales.*—One platform scale of 150-pound capacity.

(*c*) *Cutting devices.*—Two each of any of the following implements are required for use with SR, CR, and LA–100:

Large shears.
Large knife, bolo or machete type.
Paper cutter, guillotine type, with at least an 18-inch blade.

(*d*) *Measuring and transfer devices.*

1 mobile gasoline tank, provided with a metering pump.
3 5-gallon cans.
3 1-gallon cans, graduated in quarts.
3 large metal funnels, of 1¼-inch maximum spout diameter.
3 level gages for checking distances from nose to liquid level in filled bomb, such gages to be improvised wooden tees with perpendicular arm approximately 8 inches long.

(3) *Closing.*—(*a*) *Wrenches.*—Wrenches for closing the filled bomb should be two of open-end construction with 1 13/16-inch openings, or two socket-and-ratchet wrenches of the same size, or two large Stillson or monkey wrenches. The handles in all cases should be approximately 24 inches long.

(*b*) *Holding device.*—Two identical implements by which the bomb is restrained from turning during the closing operation should be on hand. These are procurable under the name of "strap wrenches." The straps should be at least 2 inches in width and sufficiently long to encircle the bomb (approximately 30 inches). Substitutes can readily be improvised with a piece of 2-inch woven belting about 4 feet long and attached to a 36-inch lever (wood or metal) so that a loop may be formed around the bomb and thus produce a snubbing action.

(*c*) *Luting materials.*—One or more of the following materials should be provided for luting the threads on the burster well:

Shellac, varnish, 1 quart.
White lead paste-in-oil (made by mixing 2 pounds of white lead with 1 quart of boiled linseed oil).
Red lead paste-in-oil (made by mixing 2 pounds of red lead with 1 quart of boiled linseed oil).

(4) *Painting and marking aids.*—The following will be required at the filling site:

1 gallon blue-gray lacquer enamel.
2 quarts lacquer, or quick-drying, waterproof, opaque marking ink for stenciling.
2 cardboard stencils cut for marking filled bombs.
2 stenciling brushes.

(5) *Protective equipment.*—Eighteen pairs of rubber gloves and twelve pairs of safety goggles are required for use of the operating personnel.

31. Handling at airdromes.—*a. Filling bomb.*—(1) *Positioning.*—(*a*) The empty bomb, nose up, and with adequate support, is positioned for the filling operation.

(*b*) The nose plug and burster well are unscrewed and removed.

(*c*) The bomb is now ready for inspection and filling.

(2) *Inspection.*—Prior to the filling of M47 bombs a careful inspection must be made to insure satisfactory and reliable functioning. The command injunctions are as follows:

(*a*) *Cavities.*—To insure that no foreign matter is therein which might interfere with proper mating of parts. (The burster well, after inspection, is carefully laid aside in a convenient place for use in later closing of the bomb.)

(*b*) *Threads.*—To insure that no rust, injury, or foreign matter will interfere with proper mating, seating, or sealing.

(*c*) *Tail.*—To insure secure attachment to bomb body and proper alinement of fins with body.

(*d*) *Lugs.*—To insure that suspension lugs are sturdy and undamaged.

(3) *Procedure when filling with solid rubber* (*LA–100, CR, SR*).—When using any one of the three solid forms of rubber, the method of filling is exactly the same and only the amount used varies. The rubber is cut into strips approximately 1 inch wide and in convenient lengths. The strips, as determined from table II, are weighed and the proper amount fed into the bomb through the filling hole in the nose. The gasoline is then measured and the correct amount poured into the bomb. An essential requirement is that the gasoline level of the filled bomb be *at least 6 inches* below the mouth of the filling hole.

TABLE II.—*Ingredients for solid rubber filling*

Type of rubber	Weight of rubber		Volume of gasoline (gallons)	Approximate percent rubber
	Pounds	Ounces		
LA–100	2	10	6	6
CR	3	10	5¾	8
SR	4	8	5½	10

(4) *Procedure when filling with liquid rubber* (*LA–60*).—(*a*) *Preparation of primary solution.*—The primary solution consists of a mixture of gasoline, coconut oil, and caustic soda, which is made

by adding 5 gallons of coconut oil to 45 gallons of gasoline in a 55-gallon drum. After the mixture is stirred vigorously for 3 or 4 minutes, 2 gallons of previously prepared caustic soda solution are added and the mixture stirred for 5 minutes more. (The caustic soda solution is made in the ratio of 8 pounds of sodium hydroxide to 1 gallon of water.)

(*b*) *Filling.*—The final incendiary solution is prepared in the bomb by adding ¾ gallon of LA–60 to 5½ gallons of the primary solution described above. The liquid level should be checked to insure that it is *at least 6 inches* below the filling hole.

b. Closing bomb.—Closing, or sealing, the filled bomb is a simple task and consists only of reinserting the burster well and nose plug. In this operation the pipe thread on the outside of the well is first coated with white lead-in-oil, red lead-in-oil, or varnish shellac. The burster well is then screwed into the adapter on the nose of the bomb until a leak-tight joint is effected. This operation will require the use of the 24-inch wrench for the burster well and the strap wrench to restrain the filled bomb from turning. Lastly the nose plug is screwed into place.

NOTE.—Some difficulty in inserting the burster well may be encountered when strips of LA–100, CR, or SR are used. However, tipping the bomb at a slight angle and shaking gently in a rotary motion will remove the obstructing strips from the well seat. This will permit the threads on the burster well to engage the burster well adapter and seat properly on the bottom of the bomb.

c. Solidification of filling.—(1) *Time required.*—The filled and closed bomb is placed in a horizontal position with the welded seam on the bottom and permitted to remain thus for the times indicated in table III so that the filling may solidify.

TABLE III.—*Time required for solidification of filling*

Type of filling	Hours
LA–60	12
LA–100	12 to 36
CR	48
SR	72

(2) *Leakage.*—During the above solidification period the bomb must be examined for evidence of leakage around the nose and along the welded seams. Leaks in bombs through the nose may result either from the fact that the burster has not been screwed to a tight fit or that luting has been insufficient. Such leaks may usually be corrected by loosening the burster well slightly, applying additional lute, and

then rescrewing the well as far as possible. Bombs in which leaks cannot be stopped should be emptied and discarded.

d. Painting and marking.—All markings on empty bombs received, *except* the wording "100 LB., M47 BOMB", must be painted out with lacquer enamel, color card color blue-gray No. 12. The words "INCENDIARY OIL, LA–60", "INCENDIARY OIL, LA–100", "INCENDIARY OIL, CR", or "INCENDIARY OIL, SR", depending upon the filling used, should then be painted below the tail hanger with purple lacquer enamel or purple waterproof marking ink, and one purple band painted midway between the two steel suspension bands.

e. Personnel requirements.—A detail of 12 men should be able to prepare the necessary solutions, fill, and mark 200 bombs in one 8-hour shift. A competent officer or noncommissioned officer should be in charge of the filling detail at all times.

f. Assembly and disassembly (fuzing and unfuzing).—(1) *Assembly.*—The field fuzing of the M47 bomb consists simply of the removal of the nose plug, the inspection and insertion of the M7 burster all the way in the burster well, the inspection and insertion of the fuze in the burster well adapter, and the attachment of the arming wire. No tools are used in any of these operations except for the removal of the nose plug. Care must be exercised when the fuze is inserted to insure that the cotter pin is in line with the suspension lugs on the side of the bomb. With the fuze in place, and with the arming wire passing through the forward suspension lug, pressure is applied to the head of the arming pin until its inner eyelet appears, through which the clean-cut end of the arming wire is then threaded in accordance with instructions on the tag. No safety clip is used on the arming wire in this operation inasmuch as the immediate withdrawal of the cotter pin and the release of pressure on the head of the arming pin transfers the pressure of the compressed spring to the arming wire. The bomb is now ready for installation in the airplane.

(2) *Disassembly.*—Should it become necessary or advisable to remove the fuze from the body, or to disassemble the complete round into its component parts, the above operations are repeated in their reverse order and all components restored to original condition and packing.

g. Safety precautions.—(1) *General.*—(*a*) The fuze in the assembled bomb, except when the bomb is released from the airplane, must be equipped with the safety block.

(*b*) The burster and fuze must be handled with care at all times.

(*c*) No attempt must be made to disassemble the fuze.

(2) *During filling operations.*—(*a*) Personnel may not smoke within 100 feet of the filling operations.

(*b*) All filling operations must be conducted in the open or in a well-ventilated shed removed from the distributing point (see par. 20), and personnel must wear rubber gloves and safety goggles.

(*c*) Care must be taken to avoid spilling gasoline upon the ground, body, or clothing.

(*d*) Caustic soda, both solid and solution, causes severe skin burns, and must be handled with care.

(*e*) Bombs must be sealed with the nose plug and burster well immediately after being filled.

32. Gasoline and oil fire extinction.—Gasoline or oil fires are easily extinguished with water except where pools are formed in such number that the fire may be spread. A spray or fog is superior to a stream of water in all cases. Commercial extinguishers, such as the soda-acid, carbon dioxide, carbon tetrachloride, and foam types, are all effective against gas or oil fires. However, the soda-acid and carbon tetrachloride types have the same limitations as water with respect to large pools of burning gasoline or oil. A wet sack or blanket or sand or earth are effective in the absence of other extinguishers.

33. Airdrome storage and transport.—This subject is treated in paragraph 20 relative to the M1 30-pound white phosphorus bomb. Where applicable, statements made there will cover the airdrome storage and transport of M47 gasoline-rubber-filled bombs.

Section VI

PACKING, MARKING, AND SHIPPING

	Paragraph
General	34
Packing	35
Marking	36
Shipping	37

34. General.—Packing, marking, and shipping of military supplies is governed by AR 30–955. This section contains special regulations applicable to shipments of incendiaries.

35. Packing.—The packing of incendiary bombs is in accordance with Chemical Warfare Service drawings and specifications, or, in the case of empty chemical bombs supplied by Ordnance to Chemical Warfare Service for filling and return, in accordance with Ordnance drawings and specifications. Interstate Commerce Commission regulations, when applicable, are observed. These latter, in general, provide for the safety of packed contents, and for the safety of personnel.

transportation facilities, and areas involved while the shipment is in transit.

36. Marking.—*a. Original and re-marking.*—Marking as a term used in this manual includes the painting, stenciling, and stamping of shipping containers. Although that upon incendiary bomb shipping boxes is primarily for the identification of the matériel from a military standpoint, it is done also to comply with Interstate Commerce Commission regulations. Briefly, these provide that boxes must be marked with the name of the content and labeled as prescribed by specific regulations. When a Chemical Warfare Service establishment repaints or re-marks incendiary shipping containers, the new

FIGURE 21.—Shipping box and metal packing case for cluster adapter M3 loaded with 4-pound incendiary bombs.

painting or marking must be a facsimile of the original, unless the Chief of the Chemical Warfare Service issues specific instructions to the contrary.

b. Salvage.—Incendiaries obtained from salvage operations and matériel which has lost its identity must be clearly marked insofar as possible to show its nature. If offered for shipment upon a common carrier, it must be marked to comply with requirements of Interstate Commerce Commission regulations.

c. Lot numbers.—Lot numbers are used in the identification of all incendiary bombs except in instances of certain unserviceable or sal-

FIGURE 22.—Method of packing 30-pound chemical bomb M1 (WP).

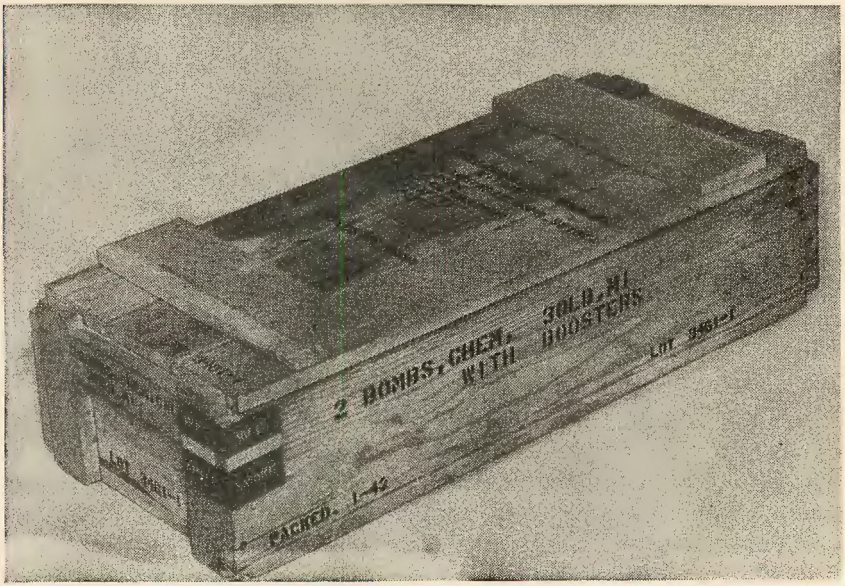


FIGURE 23. Shipping box for 30-pound chemical bomb M1 (WP) showing all markings.

vaged munitions. The lot number must always appear on packing boxes or containers.

(1) These numbers usually comprise letters and figures representing the initials of the manufacturer or loading agency, the number of the War Department procurement order, the serial number, and, in some instances, the date.

(2) Identification of incendiary munitions by lot number is essential for surveillance activities of the Chemical Warfare Service. It is also the means whereby stocks are utilized to the best advantage, and defective ammunition withdrawn from service. The lot number is

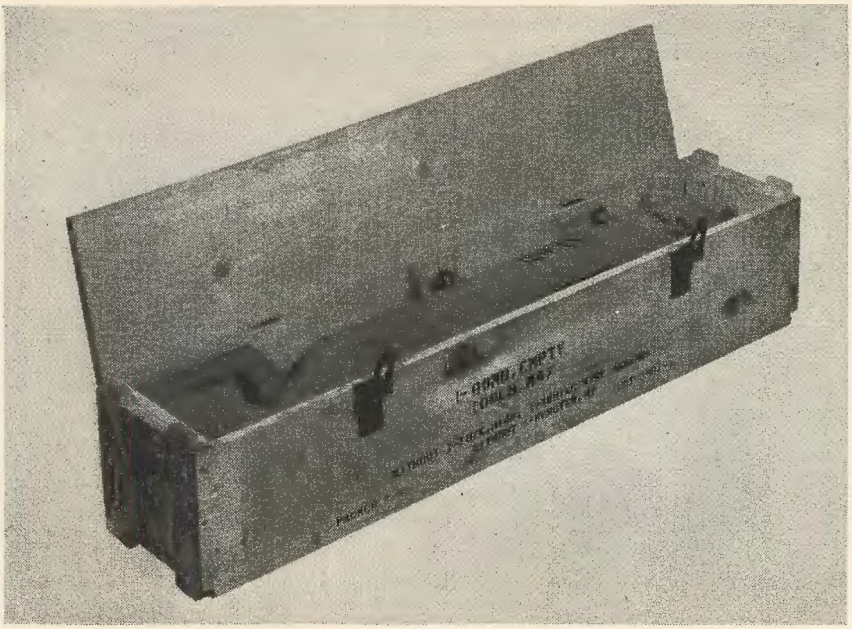


FIGURE 24.—Method of packing empty 100-pound incendiary bomb M47.

likewise employed in the selection of incendiaries for issue, inasmuch as incendiary ballistics may vary between lots.

37. Shipping.—*a. Basic regulations.*—In the shipment of incendiary munitions all matériel must be identified completely and carefully on bills of lading and shipping tickets by shipping name, type, mark or model number, lot number, and such other information as may be required by additional instructions issued from time to time by the Chief of the Chemical Warfare Service.

b. Safety regulations.—(1) Any shipment received in a badly damaged condition must be reported in detail by the consignee to the

Chief of the Chemical Warfare Service. Containers of incendiary ammunition must not be opened or repaired in any car, boat, truck, or magazine containing incendiary munitions. Ordinarily such work is done in buildings specifically designated for the purpose. In clear weather, however, it may be done in the open at a distance of not less than 100 feet from the magazine, car, boat, or truck.

(2) Cars, boats, or motortrucks in which incendiary munitions are received must be inspected by a competent person after unloading to insure that they are clean and free from loose ammunition or other flammable material, and that placards are removed. Motortrucks must be inspected regularly to insure that they are in good working order and that oil pans beneath engines are clean. The fire-fighting equipment on the truck must also be inspected.

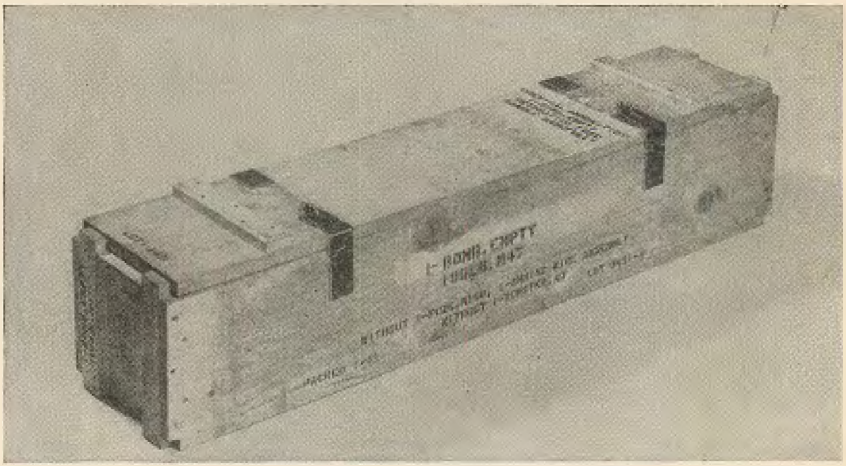


FIGURE 25.—Shipping box for empty 100-pound incendiary bomb M47 showing all markings.

(3) If cars or trucks are on a grade when unloaded, all brakes must be set and wheels carefully chocked.

(4) Incendiary munitions must be handled carefully. Bale hooks may not be used, and containers may not be tumbled, dragged, thrown, or dropped upon one another or upon the floor or the ground. If necessary to examine shipments in artificial light, only such lights as comply with the requirements of paragraph 169*e*(2), Ordnance Safety Manual, December 1, 1941, may be used.

(5) If the loading or unloading of cars is not completed during working hours, then car doors must be closed and locked or sealed.

(6) Doors to cars or magazines must be locked when locomotives, trains, or other rail vehicles used in or near magazines, or in areas

which contain explosives or munitions, are of such type as may set or communicate fires.

(7) If the loading or unloading of incendiary munitions is done outside the magazine area, then fire hazards such as dry grass or other combustible materials must be removed from the immediate vicinity, and fire-fighting equipment made readily available.

(8) A permanent record of car numbers and seal numbers must be kept.

(9) Drivers of motortrucks and those in charge of convoys must be carefully instructed and thoroughly informed concerning safety regulations governing the transportation of explosives and other dangerous articles.

(10) Danger flags and placards must be used on all trucks as required by existing applicable regulations.

c. Necessary references.—The commanding officer of Chemical Warfare Service establishments charged with shipping incendiary munitions should obtain and keep available for ready reference the following:

(1) Copies of Interstate Commerce Commission regulations, including Part VII, Motor Carrier Safety Regulations.

(2) Bureau of Explosives Pamphlet No. 6.

(3) Regulations governing the transportation, storage, stowage, or use of explosives or other dangerous articles or substances and combustible liquids on board vessels, published by the Bureau of Marine Inspection and Navigation, United States Department of Commerce.

(4) Copies of State and municipal laws and port or harbor regulations which are applicable to shipments from his establishment.

(5) Ordnance Safety Manual, O. O. Form 7224, December 1, 1941.

SECTION VII

DEPOT STORAGE

	Paragraph
General	38
Bomb, incendiary, 4-pound	39
Bomb, chemical, 30-pound M1 (WP)	40
Bomb, incendiary, 100-pound, M47 (gasoline-rubber-filled)	41

38. General.—*a. Depots.*—The three types of incendiary bombs discussed in this manual are stored in magazines or in warehouses of various kinds. Filled bombs, fuzes, bursters, and primer detonators are stored in so-called "underground igloos", while empty incendiaries are relegated to the more usual magazines or warehouses.

b. Igloo construction.—The igloo, although sometimes termed an underground magazine, is actually built upon the surface of the

ground, covered with earth at the top, and banked downward with increasing thicknesses of earth in the fashion of Arctic earth houses. It is of hemispherical design and structurally assembled of 20-foot lengths of reinforced concrete, each such section being poured at the site of assembly. The floor and both end walls are likewise of concrete. To the exterior surfaces of the dome and rear wall a membrane of waterproofing is applied. This is next coated with a layer of sand, and the whole capped with earth. Those constructed by the Chemical Warfare Service at its ammunition depots are of two standard sizes, one measuring 60 feet 8 inches and the other 81 feet in length. Except for their lengths, the inside dimensions of the two are the same, with widths of 26 feet 6 inches and heights of 13 feet. A minimum floor loading limit of 3,000 pounds per square foot is provided. This type of igloo is believed to afford adequate protection in unfavorable weather, to be most readily adaptable to camouflage, to cost little for maintenance, and to provide the best type of fireproof construction consistent with economy. A door is provided in one end only. Igloo lengths may be greater or smaller than standard if requirements so demand.

c. Igloo arrangement.—The approved arrangement of igloos at Chemical Warfare Service depots is in theoretical squares, or irregularly bounded areas, sufficient in extent to accommodate 100 igloos or less, depending upon storage requirements and the nature and topography of the terrain. The igloos therein are staggered each to the other in parallel lines and separated each from the other by 300 feet. The front of each, unprotected by earth, is faced to the north, so that as little heat as possible will penetrate to the munitions. The stagger emplacement and north facing of doors provide the greatest group safety should the door of one or more be blown outward by accidental explosion. Each 100-igloo block is separated from adjacent blocks by 600 feet, and the depot as a whole, irrespective of the number of blocks, is surrounded by a free space 600 feet in depth. A road system connects all igloos within the block and all blocks within the depot.

39. Bomb, incendiary, 4-pound.—*a. Quantities.*—The two standard sizes of Chemical Warfare Service depot igloos for the storage of 4-pound incendiaries are determined by the specification that those bombs should be stored in quantities of approximately 75,000 and 100,000. Thus the 60-foot igloo admits of 2,144 boxed clusters, or 72,896 bombs, and the 80-foot size houses 2,992 clusters, or 101,728 bombs.

b. Placing and spacing.—(1) *Rear wall.*—Boxed clusters are carried by hand or wheeled on hand-propelled dollies into the igloo from de-

livery trucks. The first stacking is done 1 inch from the rear wall, where a single section is built up box upon box (box end toward wall) until a height of 10 feet $7\frac{11}{16}$ inches has been reached and the length of the section is almost equivalent to the floor width of the igloo. The height is then that of 12 boxes plus the thicknesses of three protective layers of dunnage-grating. One section of this grating rests upon the floor, a second between the fourth and fifth tiers, and the third between the eighth and ninth tiers. The dunnage affords ventilation and stability to the stack. Between the two ends of the section and the side walls of the igloo at the floor, a space of $11\frac{1}{2}$ inches is provided, and, as the section grows in height and the curvature of the dome continues, a minimum space of 1 inch is maintained at all times between box corners and igloo wall (see fig. 26).

(2) *Side walls.*—Against the side walls the boxes are built in double sections, each box parallel to the length of the igloo, and with the same dunnage and side wall clearance provisions as with the rear wall section. By reference to figure 26 it will be observed that right-side stacking is one box-row deeper than left-side sections. This has no significance, but relates simply to the impossibility of absolute equality in stacking arrangements of several bomb types in the one-design igloo. Each right-side double section will contain 224 boxed clusters, and the opposed left-side stack a total of 200. The 80-foot igloo accommodates six right-side and six left-side double sections, and the 60-foot type four double stacks to the side. From this method of stack arrangement a center aisle of 3 feet $2\frac{1}{32}$ inches results in both igloo sizes.

(3) *Front wall.*—Stacking against the front wall is the same as with the rear, with the exception that two short sections are necessitated by the presence of the doorway.

c. Inspection.—At regular intervals to be specified by the depot commander, inspections will be made of all igloos. It is necessary at all times that air spaces be maintained between boxes and walls in order that condensed moisture on the walls may not get to the stacks.

40. Bomb, chemical, 30-pound, M1 (WP).—*a. Quantities.*—Provisions for depot storage of the 30-pound white phosphorus bomb are similar to those discussed for the 4-pound incendiary. The two standard sized Chemical Warfare Service depot igloos will provide housing, and stored quantities will, in general, follow stacking and spacing arrangements outlined for the boxed 34-bomb cluster. If packed and shipped two bombs per box, or if possibly clustered, the quantity of bombs stored will be proportional to the size of the packing boxes.

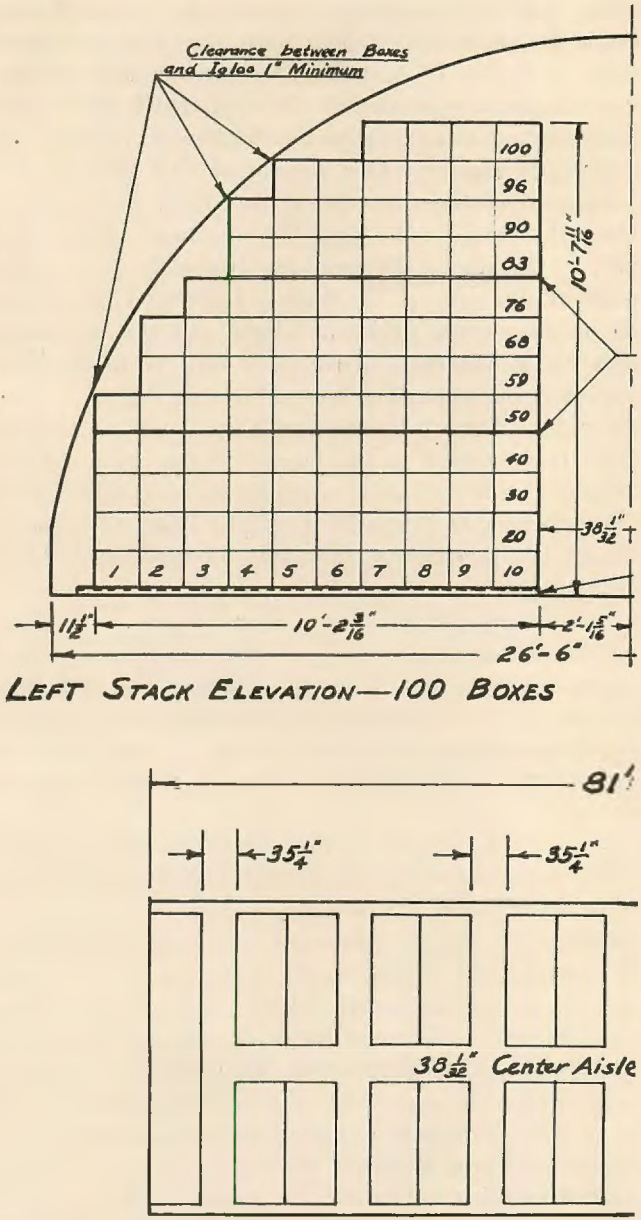
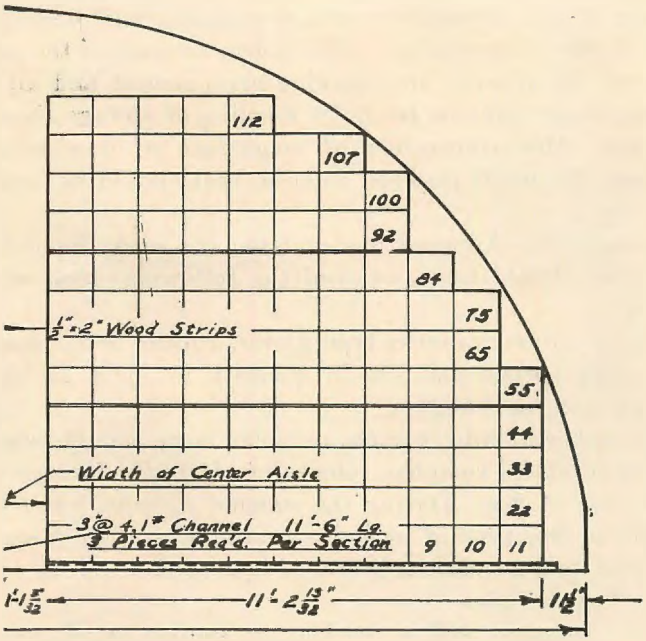
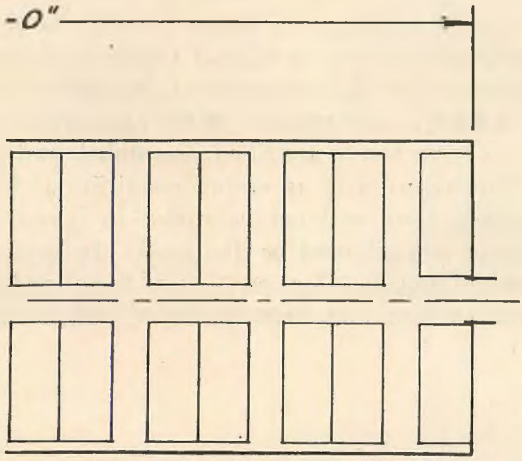


FIGURE 26.—Design of standard 81-foot reinforced concrete igloo magazine showing



RIGHT STACK ELEVATION—112 BOXES



stacking arrangement and placing of boxed clusters of 4-pound incendiary bombs.

b. Additional requisites.—(1) *General.*—Depot storage of white phosphorus bombs necessitates certain planning and provisions not required of other incendiaries. This is true because of the nature of phosphorus. In general, any stacking arrangement and all designs of housing should provide for quick flooding of storage chambers in case of fire. The temperature of magazines is likewise of great importance. If at all possible, interior heat should be kept below 111° F.

(2) *Equipment.*—Adjacent to each igloo and ready for instantaneous use there should be maintained the following items of special equipment:

(*a*) Heavy rubber gauntlet-type gloves, rubber boots, and ankle-length rubber aprons sufficient in quantity to equip all personnel required to work in the igloo.

(*b*) A number of tubs, barrels, or tanks large enough when filled with water to afford complete submersion facilities for one or more bombs in case of fire. During the summer months, when fires are most likely in this type of incendiary munitions, these tanks should be kept filled, and a sufficient length of hose so laid that it will reach to any part of the igloo.

(*c*) Two sponges and a bucket, or similar vessel, containing approximately 5 gallons of water.

(*d*) A special tub, or container, a means of heating water therein, and a small number of gauze sponges should be provided for first-aid treatment in a heated building as close as possible to all igloos.

(*e*) One glass receptacle containing at least 1 gallon of 2 or 3 percent solution of copper sulfate for treatment of phosphorus burns.

41. Bomb, incendiary, 100-pound, M47 (gasoline-rubber-filled).—Inasmuch as these bombs are filled, assembled, and fuzed in the field, and therefore received in an empty condition at Chemical Warfare Service depots, they will not be stored in igloos, and no specifications for depot storage need be discussed. In general they will be housed, where possible, for protection from unfavorable weather. Applicable bursters and fuzes, however, will be stored in igloos.

Appendix I

BOMB, INCENDIARY, INSTRUCTIONAL, M1 AND M2

1. General.—The two incendiaries discussed in this appendix have no relationship to aircraft incendiary bombs, and should not be confused with the 4-pound standard magnesium or substitute standard thermate steel-body incendiary bombs of which they are simulations. Their design, construction, ignition, and purpose all differ from the standard types. Only in the materials of their composition and the nature of their final function do they approximate incendiary bombs in the true sense of that term.

2. Purpose.—Instructional incendiary bombs are designed for the purpose of demonstrating to troops and qualified civilians the functional time element and incendiary action of certain types of incendiaries. When afire, they and the materials ignited by them provide opportunities for instruction in the methods of control of burning magnesium and thermate bombs and the extinction of fires initiated by them.

3. Use.—Since they are employed for training and educational purposes, instructional incendiary bombs are used at military and naval training centers and before civilian protective groups and agencies. Rather than being released from aircraft, dropped from stationary heights, propelled by mechanisms, or discharged from weapons, they are hand-ignited and positioned by hand upon or near the material to be set afire. Their control is thus completely vested at all times in the hands of the instructor or demonstrator. For this reason they may not properly be termed "practice" bombs as such classification is sometimes accorded to various other types of aircraft instructional bombs.

4. Types.—The two instructional incendiary bombs here considered comprise the magnesium type, designated "bomb, incendiary, instructional, M1," and the thermate type, designated "bomb, incendiary, instructional, M2." They are treated separately.

a. Description.—(1) *Bomb, incendiary, instructional, M1.*—This bomb, 2 inches in diameter and 9 inches in length, is cylindrical in appearance and constructed of an extruded length of magnesium alloy tubing. One end is closed by a tin cap held in place by an 8-inch length of waterproof adhesive tape ¾ inch wide. The 1-inch diameter

core is packed with the thermate igniting mixture to within ⅝ inch of its fuzing head. This remaining space is then filled with the first fire charge to within ¼ inch of the end of the bomb, at which point a metal closing disk is inserted and secured by a second strip of 8-inch waterproof adhesive tape. All fillings are subjected to a pressure of 5,500 pounds per square inch. Three holes perforate the closing

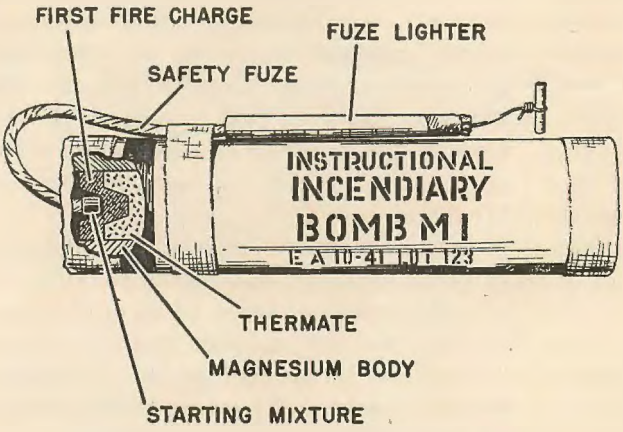


FIGURE 27.—Instructional incendiary bomb M1.

disk, one in the center and two ⅜ inch off center. An 8-inch length of safety fuze, one end of which has been treated with a mixture of collodion and black powder and rests within a depression of the first fire charge, passes through the center hole, curves up and back, and is taped to the bomb. After the installation of the fuze, the rim of the center hole is sealed with cement and coated with quick-drying shellac. The off-center holes of ¼-inch diameter, serving as gas vents, are covered with ¾-inch squares of waterproof adhesive tape and coated with varnish shellac. A pull-wire fuze-lighter is taped to the bomb but not assembled to the fuze.

(2) *Bomb, incendiary, instructional, M2.*—Only in structural substances and in minor details does this thermate bomb differ especially from the foregoing magnesium type. The M2 instructional incendiary bomb is likewise of 9-inch length, but its body has a diameter of only 1½ inches and is constituted of steel tubing $\frac{1}{25}$ inch thick. One end is closed by a tin plate, friction fitted and soldered, the other by a similarly soldered plate containing a center fuze hole and three vent holes equally spaced around the center. The body filling consists of thermate capped by a first fire charge. A 6-inch powd

train time safety fuze tipped with a collodion and black powder mixture is assembled in the same manner as in the M1 bomb. The vent holes are taped; both they and the rim of the fuze hole are treated with commercial liquid solder to insure waterproofing. A pull-wire fuze-lighter is taped to the bomb but not assembled to the fuze.

b. Ignition.—After ¼ inch has been cut cleanly from its end, the fuze is inserted in the fuze-lighter with moderate pressure. The bomb is then held firmly in one hand, with the thumb pressing the fuze-

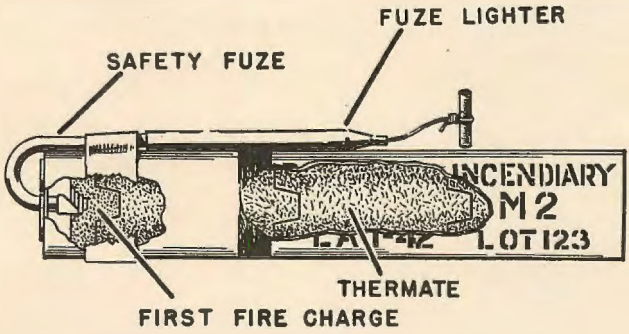


FIGURE 28.—Instructional incendiary bomb M2.

lighter flat against the bomb body. With the other hand the handle of the fuze-lighter is pulled sharply away from the fuze, which will burn for 30 seconds before igniting the first fire charge. The M1 bomb burns for approximately 5 minutes, the M2 for approximately 75 seconds.

c. Safety precautions.—The following safety precautions should be observed when igniting instructional incendiary bombs:

(1) Protect the hand holding the bomb with a heat-resisting glove or pad.

(2) Point the fuze end of the bomb away from the face and body when pulling the fuze-lighter.

(3) Place the bomb in its predetermined incendiary position immediately after pulling the fuze-lighter.

(4) Stand at least 10 feet from the bomb after it has been placed in its incendiary position.

(5) Remain in such position for at least 30 seconds after the *bomb* has ignited.

5. Markings.—The instructional incendiary bomb is marked with one band and lettering in purple lacquer enamel to indicate its type, the initial or symbol and lot number of the loader, and the date of filling.

6. Packing, marking, and shipping.—Bombs are packed in cartons designed to contain four bombs each, and thence packed in wooden boxes designed to contain from six to eight such cartons. Packing cartons and shipping boxes are both marked in the same manner as the bomb body.

7. Storage.—Instructional incendiary bombs are stored in dry magazines and at all times handled with care.

8. Bomb extinction and first aid.—The extinction of magnesium and thermate incendiary bombs is discussed in paragraph 10 and first-aid treatment of burns in paragraph 11.

APPENDIX II

LIST OF REFERENCES

Bombs for aircraft ..... TM 9–980
Incendiaries ..... Chemical Warfare School Pamphlet No. 3
Ordnance Safety Manual ..... O. O. Form 7224
Shipment of explosives ..... Interstate Commerce Commission, Bureau of Explosives Pamphlet No. 6
Storage and shipment of dangerous chemicals ..... TM 3–250

[A. G. 062.11 (2–14–42).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

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